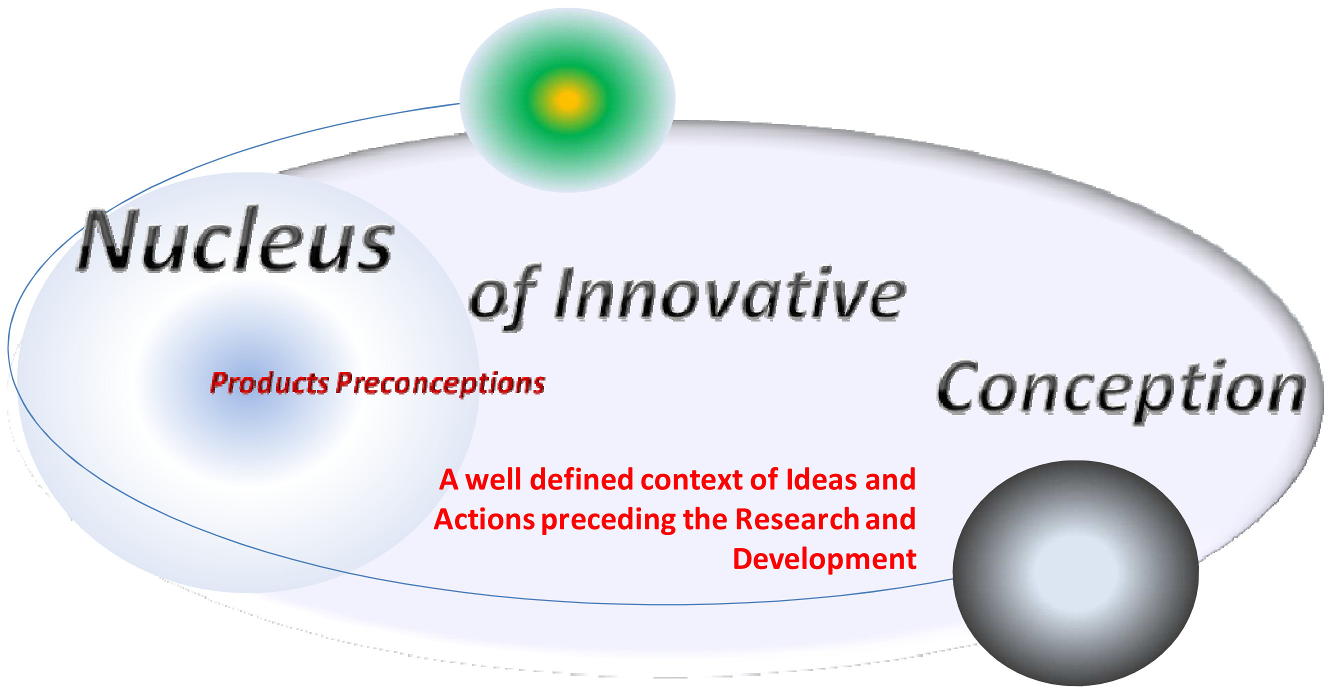

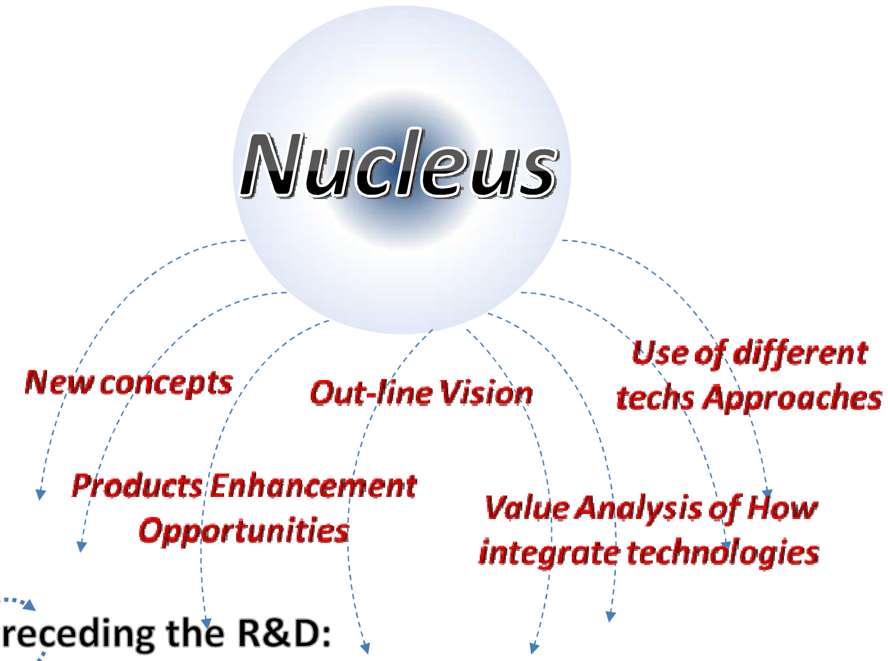

Preceding the R&D:

The Nucleus use different finds of technologies approaches in order to create a data-base of opportunities for improvements and new conceptions of products, establishing a R&D scheduling.

Abstract

Resume:

The article presents a scope of denominated Nucleus of Innovative Conceptions that regarding as a new proposal of technology creating as well as a studding approach. That it is means the Nucleus elaborating innovative ideas of products, preceding the former Research and Development stages of each specific industries and research centers.

The possibility of Nucleus establishing new concepts of technological products it is originally realized through the opportunity to integrate some of most representative technologies approaches, segmented over all different industries and markets.

The Nucleus preceding the former R&D considering the following reasons:

(i) **A specific Industry or Research Center does not normally considering an out-line vision of others markets and knowledge fields, potentially causing a lack of technical integration**;

(ii) **The possibility of integrating the diversity technological approaches represents great opportunities of products enhancement, cost reduction and new conceptions**;

(iii) **Based on the broad possibilities of technical integration, the Nucleus conceptualizes new proposals in terms of a technology re-contextualized.**

Therefore, the Nucleus operating this knowledge construing a constant database, considering for that a diversity of technical approaches in terms to add value in new products or actual products to be improvement.

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Nucleus of Innovative Conception

Elaborated by **Paulo Gustavo Borba Cordaro**.

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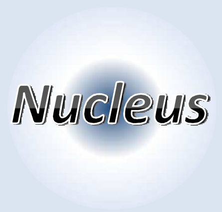
1 Nucleus Overview

This chapter present the following contents:

- Nucleus explanation
- Nucleus definitions and approaches
- Nucleus proposing

Explanation



The idea of denominate an organization oriented to conceptualize technological products, based on the variety knowledge fields around the actual technologic scenario or context, originated from the same term used to define a R&D center. Therefore, the conception of center, middle, zero point, nucleus and others similar substantives has been correlated with the definition of where the ideas or conceptions came from; considering for that, the join of all resources necessary in order to bring to society new technologies and conceptual products.

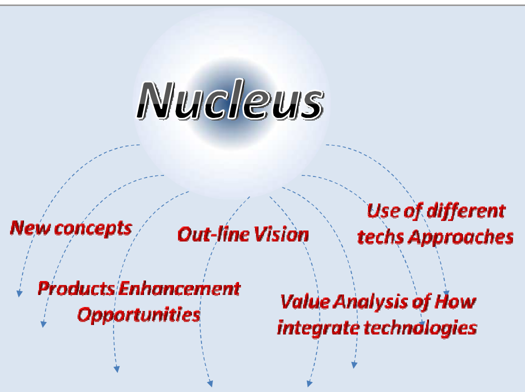
However, the Nucleus could not be in conflict with a R&D center, being a competitor; and so, it should be the organization that allows the R&D activities in order to obtain an integration well oriented related to the relevant objectives, costs and deadlines of a project; establishing the Nucleus as a partner of this challenger to produce technologies.

Based on, the Nucleus is an organization that produces conceptual ideas of products or technical approaches, allowing the variety of R&Ds follows at the constitution and enablement of future products and technological definitions.

For this reason the Nucleus precedes the R&D activities, supplying it with relevant ideas of products, regarding the capability of integrate opportunities of already established technologies.

Nucleus is a provider of research constituted by an innovating process, originated by the simple idea of perform cross-reference information about variety of state-of-arts already established that allows dazzle new possibilities of products based on cost reduction and efficient increase.

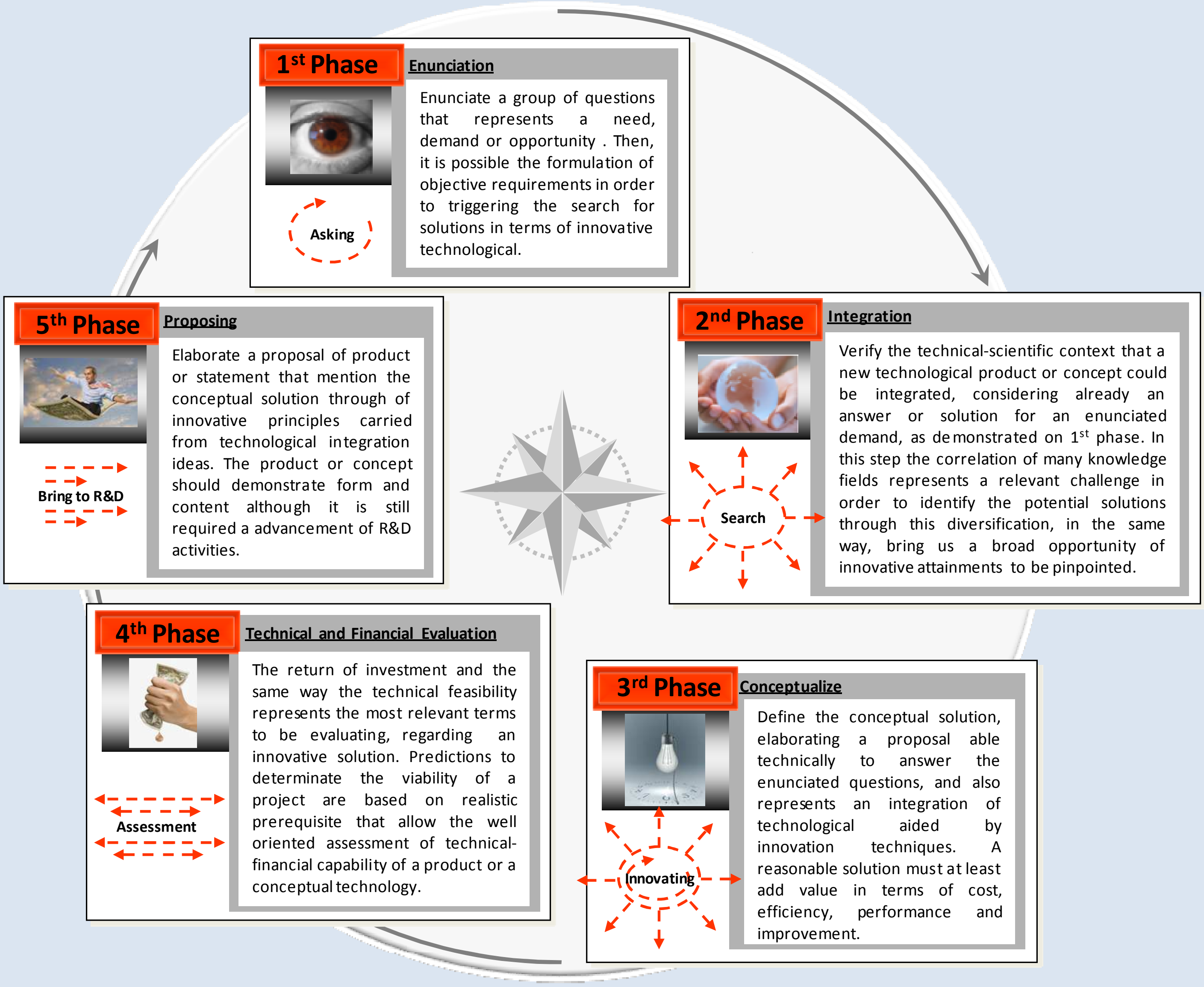
Definition and Approaches applied



The Nucleus functionality has based on its creative capacity in order to determine technologies opportunities. For that, the Nucleus utilizes a serial of techniques in order to establish an innovative process that allows determining the prepositions of new technologies to be conceptualize.

Therefore, to reach this primary objective the Nucleus use a throughout understanding of actual technologies in order to identify new possibilities of a product or technological conception. In addition, the major definition of Nucleus related to a single principle, that it is considering an innovation process as the key element to lead toward conceptualizes products or technical approaches, as previous alternative of former R&D activities.

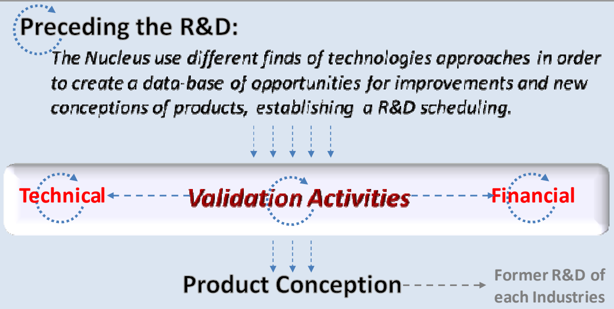
Although the innovation term is difficult to be precisely defined, the Nucleus has been applying this fuzzy idea in order to complete itself definition, considering essentially five activities or phases for innovation of a process that provides the Nucleus with the ability to formulate questions that will represent an enunciate related to technologic demand or needs. Thus, the Nucleus approach has defined in the following diagram that demonstrates the related phases of innovation.



Based on, **the Nucleus definition is mapping a specific knowledge field to understand the actual technological situation and formulate opportunities in order to increase this state of art, adding new products or new technologic approaches, regarding a thorough and broad inter-correlation with others knowledge fields, integrating solutions previously unknown.**

The following chapter already demonstrating some technologies areas mapped in order to presents new products and technological approaches. This proposals represents a Nucleus storage of opportunities related to technological improvements of specifics state of arts that could be considering stagnant in terms of a relevant increase (e.g. cost reduce and performance enhancement). However, considering the Nucleus principle related to assessing the possible integration, aligning innovative correlation of separate knowledge fields, there are proposed interesting conceptual ideas of new products to be evaluating by R&D centers.

Proposing



Even that the Nucleus proposals could be considering as relevant technological opportunities, there are necessaries technical and financial evaluations in order to determine the project viability. Thus, the Nucleus presents a variety of projects, and there should be well evaluated (technically and financially), regarding basics principles of assessment and appraisal.

Therefore, **the proposing projects of Nucleus represent the definition of a product conception and an investment request, simultaneously**.

The basic principles of assessment, regards the definition of theoretical validation that it has accomplished with an itinerary calculation sequence, respecting a well oriented technical verification in terms of feasibility and reliability. In addition, the financial appraisal has based on the return of investment rate, considering well-established assumptions and premises of cost, amount invested, period of return and gains opportunities.

Other concept that is extremely relevant in terms of proposing and demonstrating new technological opportunities, regarding to Value Engineering method. This methodology drive to function definition related to cost involved into a project, for example. The Nucleus applying this method, because it has demonstrated as a valuable way to establish the measurement of gains related to new technological proposals.

Based on, the following list represents the most relevant products already conceptualized. The list demonstrating a summary of each technological opportunities, established as a product and the value of this opportunity enabled as a measurable function. In addition, the details of each product project there are demonstrated on sequence chapters.

Product Conception – title	Knowledge Field	Principle of Innovation – **add value function**	Reference
Airfoil lift force improvement section	**Aeronautic / Aerodynamic**	Redefinition of aerodynamic adjustment based on the establishment of second flow inside of wing – Cost reduction of air-operations by the decrease of volume of fuel needs or increase the weight loaded or increase the cruise velocity	Page 06
Airfoil trailing edge drag force reduction component	**Aeronautic / Aerodynamic**	Air-performance Improvement – Decreasing of Drag effects and Increasing the cruise Velocity	Page 06
Engine based on fluid flow due to vortex establishment by forced pressure variance	**Automobilist**	New arrangement for efficiency enhancement of engine – New Alignment of high power, high rotation and low fuel consuming, based on at engine functionality by burning fluids into vortex movements, without moving components.	N/A
Brake system based on kinetic energy dispersal by fluids at contrary movement	**Automobilist**	New brake system without wear and maintenance between components – Energy Dispersed by fluids flow located into pistons opposed to the wheels rotation, dispensing components of contacts	N/A
Gearshift system based on a coupling of parallel shafts by a non-concentric rotation	**Automobilist**	New gearshift system with a variety of velocity adjustment aligned with reduced dimension – A simplest system of rotational velocity adjustment based on pulleys coupled by a shaft non-concentric and with settable coupling position	N/A
Actuator and sensor for the electromechanical conversion due to a pantograph shape	**Electro mechanical / Robotic / MEMS**	New electromechanical conversion device – Applicable as actuator and sensor, simultaneously for the electromechanical conversion, affording a reversing of electric and mechanical energy by the establishment of electromagnetic flux inverted	N/A

Innovate Technology Proposal:

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1 Air Innovation – The proposal

This chapter has the following contents:

- Preface of Air Innovation
- Enunciation of Air Innovation
- The innovative proposal

Preface of Air Innovation

The knowledge field of aeronautical science gathers high representatives on value added to the general society. Recurring of that, these influences altering the roll of possibilities in logistics transport, and therefore increase the productive, economics and financials scales. From the flight property, that is a remarkable achievement in terms of historical evolutions and technology development, the air transport of cargo and people is an encouragement to the socioeconomics environment, regarding the efficiency, rapidity and security.

This integrating property from the appropriate use of techniques, empirical concepts and physical assumptions established the flight as such as the boundary of further developments over trade, social, economic and military relations. Constituting there the stakeholders and major provider of air-transport as an element of high advancement and contents in order to achieve the operational performance and capacity improvement.

The preamble of these actual results is consequence of a shrewd sense of perseverance and persistence of visionary men, considering the confusions, constraints and difficulties reality on early experimental flights. However, considering the fact that theories were not defined yet in order to complementing the experimental air-flight conditions, the practical innovative acts prevailed, and the firsts air-flight with a heavier machines occurs and consequently the evolution and subsequent innovations have never stopped, causing the most significant advances.

Also a state of the art was established which then steadily increased the conceptual and theoretical basis of this science, thereby determining other direction even more ambitious, such as conducting space flights and exceeding the speed of sound, for example.

There are others relevant factors associated to socioeconomics and capital relations issues, which determines the pace and need toward aeronautics technological development. However, since the experimental flights, until the actual high scales of commercial flights, the technical evolution of the wings profiles (and own aircraft) represents a refinement of the state of art at transporting people and materials, with significant efficiency and productivity. Whereas, for the latter case, the basic elements of measurement over logistics operations as such as deadline, cost and volume of items displaced.

Considering the current stage setting of aeronautics knowledge field, there is not totally equivocated the idea that continuous improvements on airfoils profiles is near to be regarded on seedless period or on a limit situation of new innovative projects, at least on civil design segment. Although, there is a marginal improvement in the practical and theoretical concepts to enhance the flight capacity, regarding certain requirements such as reducing fuel and operating costs.

Thus, a statement related to aeronautic innovation that will be conjecturing (briefly) the theoretical field of flight, toward to define the principles of innovative opportunity for gains on flight capacity.

Enunciation of Air Innovation

What primordially on current techno-sciences conjecture will define a technology on aeronautic state-of-art as innovated? Which parameters could be use to allow evaluating the innovation, effectively? What does parameter or any other measurable elements will be use to determine a proposal as innovative? Does the establishment of an innovated technology proceed to an economic-financial evaluation, juxtaposed over returns and investments? Is it possible, considering the actual technological knowledge, an innovating action immeasurable (in numerical terms)? Which values analysis of an innovative proposal has better effectively: the empirical or the theoretical?

Questions just above-mentioned that determining on wide terms, essentially, how innovating it is a proposal (i.e. technological proposal, creative solution, crosswise solution, R&D result), regarding the incremental functions of aeronautics knowledge field. However, there questions should be better formulated in order to specifying precisely which needs that the innovative solution (proposal) will provide.

Than, the answers mean a significant challenge, regarding a proposal as innovative solution, considering thereof with a potential of research and development feasible to be assessment.

For that, should be primarily determinate the enunciation of actual aerodynamic sciences situation (i.e. practical and theoretical), in order to establish the key issues that denote a technological demands, or at simplified manner, the needs addressed by innovative solutions.

The procedure to enunciate the needs requested to innovate solutions there is determined by the simply examination of lift force formula, observing for that some premises and objectives for functional increases.

The premises there are obtained consider the arrangement elements of lift-force formula, regarding also the functional objective of airfoil. Thus, the elements of lift-force formula there are the key-drives in order to achieve the fly proprieties of airfoil and the airplane, respective. The airfoil adjustments follows the variation of this key-drives inserted in lift-force formula, combined with wings fit. Thus, on conception level, the premises are obtained considering the following analysis:

- Lift Formula and the key-drives involved:

$$L = C_l \times \frac{1}{2} \times \rho \times V^2 \times A$$

L ⇨ *Lift*
C$_l$ ⇨ *Coefficient of Lift*
ρ ⇨ *Air Density*
V ⇨ *Velocity*
A ⇨ *Wing Area*

- Premises and Objectives of Technology Innovation:
  - **Velocity**:
    A reduction of take-off velocity is desirable as proposal of improvement, considering their benefits related to add value (i.e. cost reduction, efficiency gains) to proprieties of flight. A reduction of this velocity could represent gains associated to physical efforts (e.g. work applied to determinate the adequate displacement) of airplane starter method.
  - **Wing Area**:
    An objective also desirable there is a wing geometric development in order to allow an aerodynamic performance of lift upward and drag effects well balanced. Thus, reduced wing area is relevant to

decrease the drag force; however, it does not also represent a reduction of lift upward whether a balance device exist in order to compensate the lift-force over the reduced wing area section.

- **Coefficient of Lift**:

  This element associate the area section proprieties with angle of attack applied in order to determinate the lift capability of airfoil. Based on, an innovative premise should determinate the adjustment of all functionalities interesting to be aligned such as high lift on low velocity and large angle of attack range.

- **Air Density**:

  Considering this element as a non-controlled variable for airfoil dynamics working, however the turbulent airflow represent an elevate Reynolds number that contribute to increase the airfoil lift functionality range. Thus, on adjustment-controlling mechanism could add a dynamic balance for any air ensemble (e.g. airfoil, wing, and airplane).

Therefore, weaving an extremely simple evaluation of lift-force formula (and not ignoring the minimal conceptual literature that involves theory of flight, however explicitly omitted in this document for reasons of summarization), there has essentially obtained the statement of principles (Premise, Aim and viability) of desirable innovation in the actual aeronautic technological context, such as below described.

- **Principle 1 – Low Velocity**:
  - Premise: In order to allow a resource rationalization, considering that the effort used in the initial displacement oriented to obtain the minimum velocity enough for lift upward, represents the constraints most restrictive in terms of establishment of flight.
  - Aim: Reducing the initial velocity required to flying of airplane and similar without a decrease of lift capability, based on auxiliary mechanisms (innovative solution) usage that allow a lift upwards increases.
  - Viability: Development two aerodynamic mechanisms controllable oriented in order to increase the lift upward on low velocity conditions or required.
- **Principle 2 – Progressive geometry of wing**:
  - Premise: The conjecture of wing profile and it geometry (i.e. area and shape) are primordially settable elements in order to determining the lift upward capability of airplane; however a balanced combination of this variables is very complex to be reach, regarding increased cost and schedules on new wings research, development and design processes.
  - Aim: Reduce the wing area, simplifying the design process and increase the airplane maneuverability, without lift upward capability loss.
  - Viability: The aerodynamic mechanisms allow the wing designing on feasible terms, regarding an elevate performance in all velocities scales, considering that the aerodynamic mechanisms increase the lift upward capability in order to compensate the low velocity, reestablish the performance range of wing lift upward (included the drag effects reduction and minimum point of wing performance change).
- **Principle 3 – Elimination of elevate lift-force upward restrictions - Turbulence manipulation as an aggregator of improvement**:
  - Premise: An elevate Reynolds number allows a lift upward increase, considering that it obtained from the proprieties of dynamics airflow, independently of airfoil characteristics.
  - Aim: Adding the high turbulence effect as key driver in order to reach an elevate lift upward, allowing rationalization and better efficiency on aerodynamics components of airfoil conception.
  - Viability: As mentioned above, a group of mechanisms should be development in order to aid

the lift upward establishment without a counterpoint loss (i.e. drag force increase), also considering this aerodynamic mechanisms feasibility in terms of adjustment, controlling and safety.

Considering the lucubration as above mentioned of the tree principles well as an aeronautic innovative initiative, this enunciate represents a proposal description of optimization and effective aerodynamics capability increases, regarding the airfoil, wing and auxiliary mechanisms on lift upwards context.

The Innovative Proposal

The following proposal description does not represent a negation or exotic theoretical term establishment, related to actual aeronautics conceptual knowledge basis. The proposal aims an analysis of main elements that determining the surface pressure and Reynolds number alterability as well, invariably, adds significant improvements on lift upwards of airfoils as the optional use of auxiliary mechanisms.

The auxiliary mechanisms designation representing technical options that allowing the increase of airfoil coefficient lift, without previously changes over wing and it profile geometry, as also, the angle of attack for usual flows regime of operational situations.

Therefore, the major objective of this article is demonstrating two auxiliary mechanisms as such innovative new elements related to context of wing (i.e. airfoil, wing profile, wing geometry) lift upward capability, that with the application of both mechanisms the wings context are able to perform lift effort on better situation of mass conservation and energy optimization.

Rigorously, the wing profile remaining unchangeable considering their dimension and geometry; however, a significance modification on pressure relations alterability, resulting of air flowing-off at the airfoil upper and low surfaces occurs. The innovative proposal consist in creating auxiliary mechanisms (i.e. airfoil lift force improvement section, and airflow trailing edge drag force reduction component), which adds substantially on the wing function upwards, altering the pressure relations inside airfoil. The result is the gaining of possibilities in the project definition of wing and airfoil, considering all attributes inherent in the requirements of wing development or improvement.

These auxiliary' mechanisms there are not a similar device as Slats or Flaps that are applying on landing, for example. The both mechanisms are designed to be useful for all transitions steps of an airplane (i.e. take-off, maximum distance range of flight and height, and landing). The operating principle of these mechanism is based on controlled and well-oriented air flowing turbulent (observed the vortex phenomena) in determinates area-sections distributed for the airplane wings.

The mains aims of these mechanisms are increase substantially the pressure gradient of wing (i.e. increase the pressure on lower surface, also than decrease the pressure on upper surface) and put against to drag flowing-off generation. The key-driver element to allowing this aims is a high turbulence flowing based on vortex generation, obtaining by a secondary airflow into wing section oriented to redistribute the pressures scales around the airfoil, and then, improve the wing upward and forward performance.

On resumed terms, the vortex represents a circular / spiral movement due to the pressure altering between the center and commonplace of extremity. Considering the vortex as a high turbulence element, itself generates on a new area section on lower surface of wing that provides the vortex formation due to air mass diverted by the upper surface. Thus, the upper surface of wing suffers a pressure reduction as consequence of this air mass escape, and also the lower surface is benefited with pressure increase due to vortex formation. Therefore, the consequence of auxiliary mechanism named “airfoil lift force improvement section” is providing the airfoil a peculiar differential related to mass conservation principle, regarding the elevated pressure gradient between the upper and lower surfaces of wing.

Moreover, the other auxiliary mechanisms, named “airfoil trailing edge drag force reduction component” represents one more element related to mass conservation principle based on the final section of wing (expressed such as wing-tail or trailing edge). Considering the air mass escaped of upper surface, specifically on initial section of wing (expressed such as leading edge), this mechanism provides on trailing edge an additional airflow that avoid the flow-drag generation, regarding another vortex formation that countered the flow-drag due to distinct pressure gradients.

Consider the following group of illustrative scheme, which demonstrates the interaction and direction of movement of fluids following the direction of vortex formation.

The following illustrations demonstrates the interaction and direction of airflow movement on airfoil, regarding the usual acting (i.e. actual technology approach) and within the auxiliary mechanisms based on innovative technology (i.e. vortex operating for pressure gradient increase and flow-drag decrease).

The first illustration demonstrates a semi-symmetric airfoil on normal conditions of functioning in order to establish the comparison basis with the innovative proposal, as below.

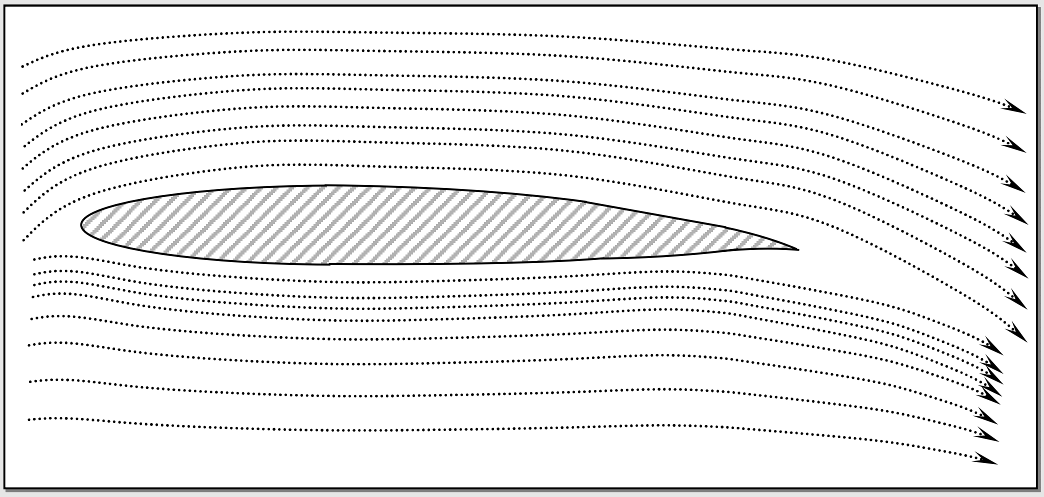


Figure # 1

The dashed lines are a representation of the air mass flowing over the wing profile, and the distance between each dashed line shows the pressure gradient in each area section. As well, changes direction represents the variations of displacement of this fluid.

Therefore, the figure # 1 symbolizes the dynamic airfoil operating, without prescribe auxiliary equipments that usually it applied (such as slaps and flaps, for example) on airplanes. In addition, aims to demonstrate that the technology feasibility it is described on definition of size, profile, shape, structure and function of wing.

The next figure denote an auxiliary mechanism named “airfoil lift force improvement section” that it is possible observe new aerodynamics flows from the forced and controllable movement of a secondary airflow. Such secondary airflow gets a circular dynamic in order to generate vortices, and thus a significant increase on turbulent flowing-off. However, this turbulence does not cause a detachment on contact surface between fluid and wing, because vortices generating occurs inside of wing (specific internal area section).

The following illustrate (figure # 2) demonstrate the vortex generated, highlighted in red dashed lines, derived from the addition of a secondary flow (also highlighted in red dashed lines). The usual dashed lines show the dynamic displacement of air, such as the pressure increase in the lower surface, causing by vortex, and a reduction in upper surface pressure, causing by the air draining on the leading edge flow and along the chord length of the airfoil, also.

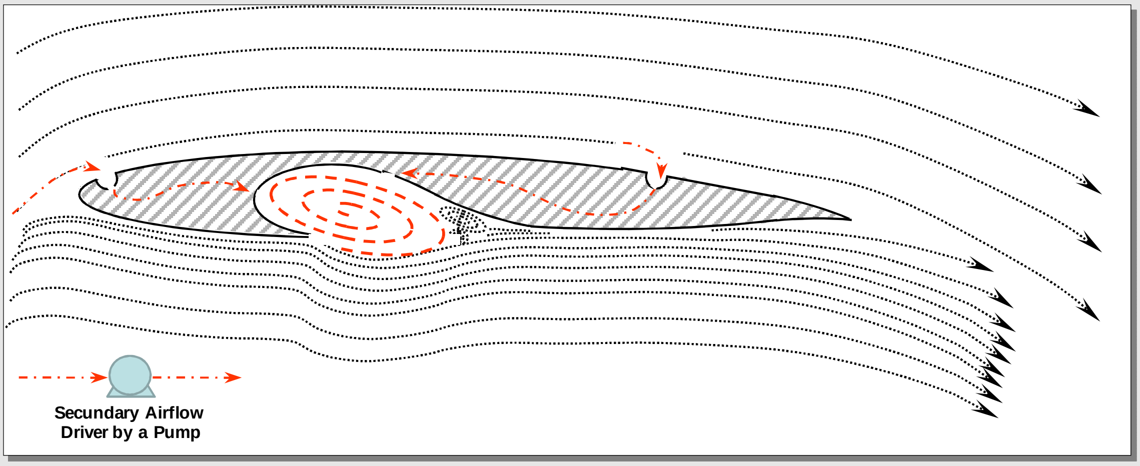


Figure # 2

Therefore, considering the encouragement of the secondary airflow toward adds a dynamic flowing-off into lower surface, instantly causing a draining of air on upper surface, thus auxiliary mechanism named “airfoil lift force improvement section” offering the possibility of an adequate lift upward of airfoil considering a low velocity of airplane movement.

The drive of secondary airflow occurs by a special pump designed in order to obtain an adequate airflow in terms of pressure and volume, allowing the vortex generating and also the elevate pressure at low surface.

The position of “airfoil lift force improvement section” is not necessarily along the wing, and so allocated on relevant coordinates that adds value in order to increase the upward capability of wing, considering yet more than one mechanism could be applying. Otherwise, regarding this mechanism as such auxiliary equipment the same could be deactivating due to a manual or automatic control already settable (i.e. high velocity of airplane becoming unnecessary the use of this mechanism).

A relevant comment of “airfoil lift force improvement section” related to adequate functionality in terms of security. Considering that, this device works due to a vortex generates and some special adaptation in geometry of wing section, so the secondary airflow will exist with an implicit risk of inadequate or malfunction that could cause an unfortunate effect. In this case, relevant variables of control and functionality preservation (i.e. vortex air mass abrupt dislocated along the main camber line causing a vacuum in mechanism section) should be considered on the project and assembling of this mechanism on airplane conjunct. In order to minimize this risk, the section of vortex generates should be sized and posited parallel of primary airflow direction within sensors and control supervision already installed and reliable.

The other mechanism named “airfoil trailing edge drag force reduction component” is able to decrease the drag force effects (named “downwash”, also) over airfoil performance, regarding a better airflow escaping due to trailing edge adjacent preventing the turbulence flowing-off related to drag vortex formation. This vortex causing a reduction on aerodynamic performance of airfoil related to low airflow relative velocity after trailing edge of wing.

In order to prevent this issue (i.e. associated to previous displacement of upper and lower airflow that join on trailing edge, causing the vortex formation and drag effects) of performance the auxiliary mechanism is designed to inject a secondary airflow (deriving from upper surface and leading edge) from trailing edge in order to disestablished the drag vortices formation due to the balance of high and low pressure zones of vortex.

For that, a special drain tube introduced on external extremity of wing in order to eject the airflow into vortex middle line, causing a rebalance on pressure alterative that is a typical trait of vortex formation.

In the following figures, this mechanism demonstrated before a simply brief of drag vortex formation.

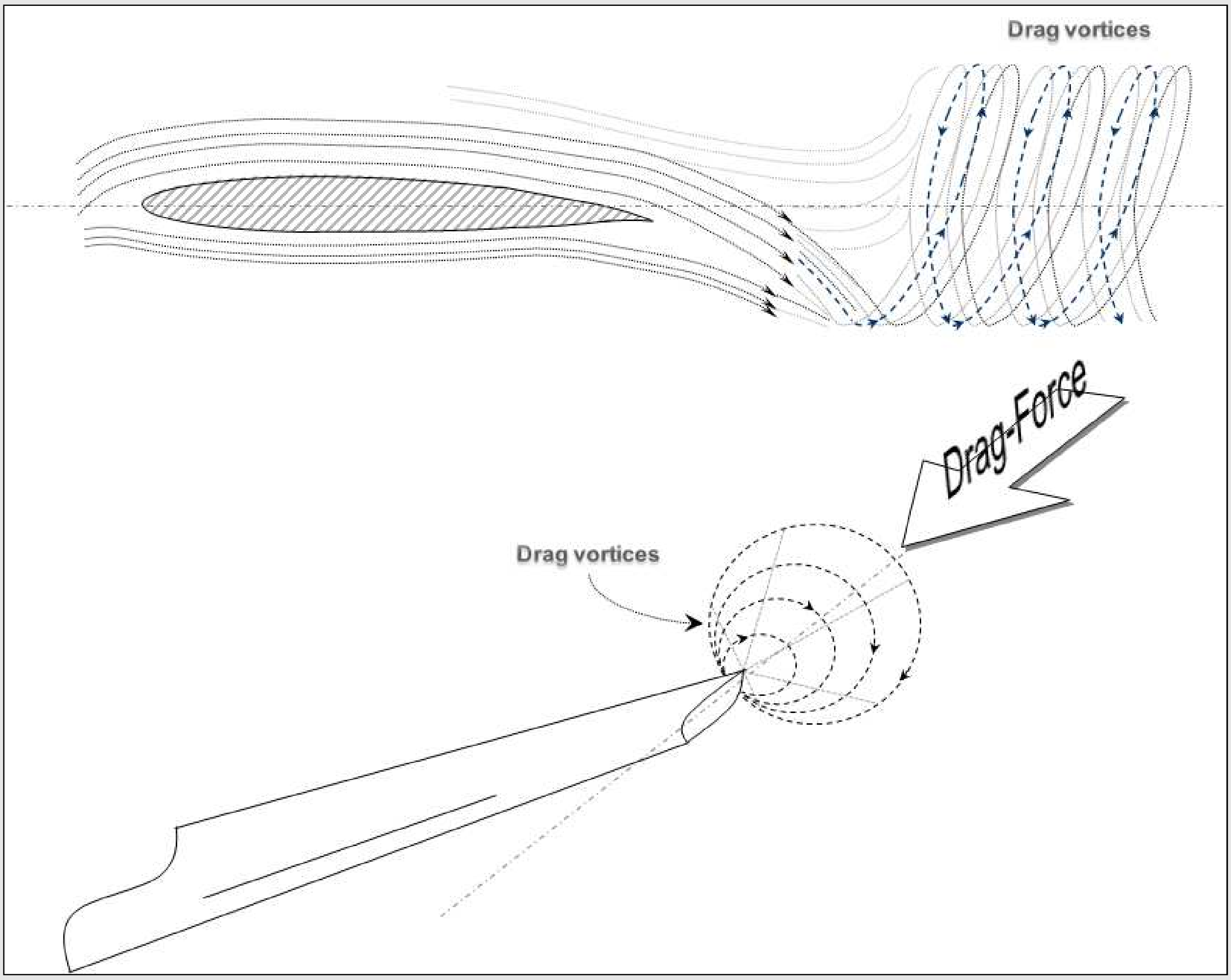


Figure # 3 – The vortex formation on wing extremity, causing the drag force effects (downwash)

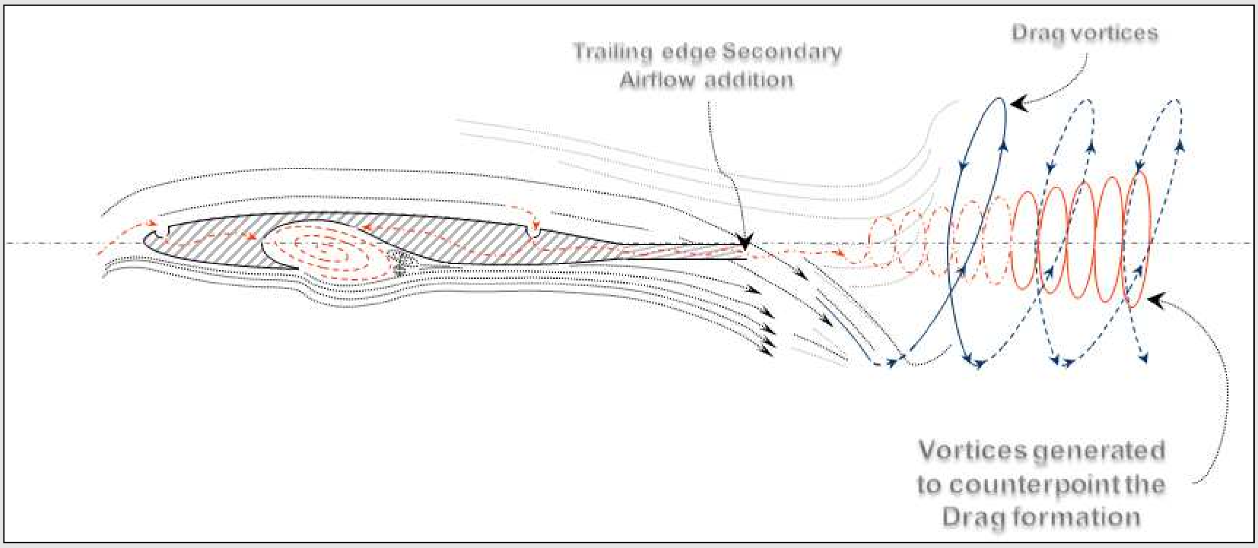


Figure # 4 – The mechanism named "airfoil trailing edge drag force reduction component" performing, joined with the other auxiliary mechanism named "airfoil lift force improvement section". The mechanisms draining the airflow deriving from upper surface and leading edge in order to increase the lift upward and decrease the drag-force effects

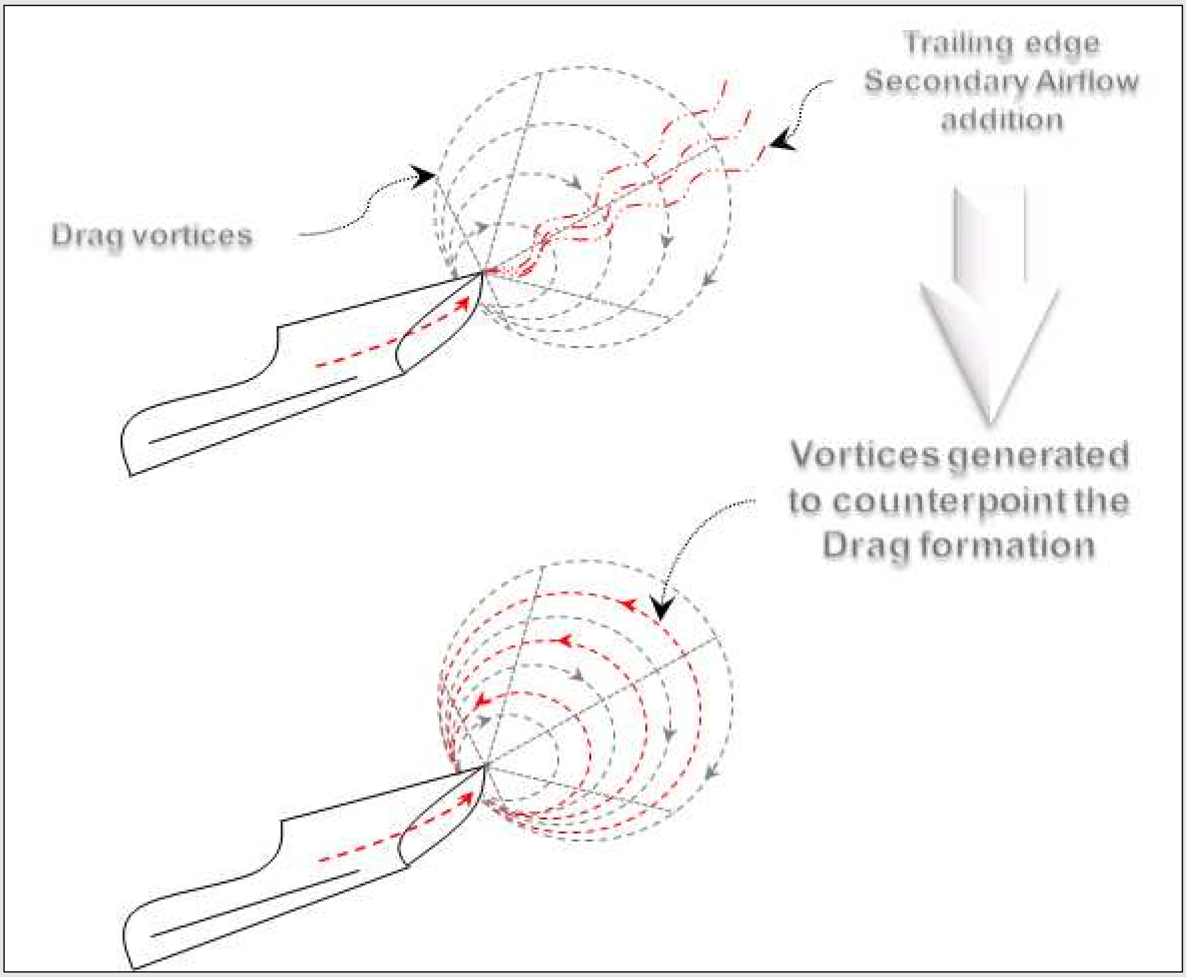


Figure # 5 – The auxiliary mechanism named "airfoil trailing edge drag force reduction component" performing the drag vortices annulations

Therefore, applying the auxiliary mechanism represents an improvement of feasibility and functionality into flight context, regarding the capability and performance increases of air logistics operations within a dramatically cost reduction.

Otherwise, the both mechanisms considering the possibility of deactivation or their functionalities associate to pertinent operational situations (i.e. take-off, landing, velocity range), essentially regarding the securities issues and settable steps oriented to sensors and actuators controlled.

The mechanisms represents an interesting opportunity of enhance of airfoil performance in order to established a paradigm shift, considering the improvement of two parameters usually contradictory. This paradigm normally defined on situation of a cost reduction (first parameter) without a travel velocity (other parameter) increases. The shift consist in allow both situations on same moment, causing a simultaneous enhancement of airplane performance thus a cost reduction within a travel velocity increase.

Other favorable point to demonstrating the value of mechanisms is the usage combination that represents the altering of possibilities of mechanisms applying, considering for example the situation of maximum velocity and height, the mechanism "airfoil trailing edge drag force reduction component" could be using at once in order to reduce the drag effects. Otherwise, the mechanism "airfoil lift force improvement section" could be applying on landing and take-off situations, considering the benefit due to lift force increases.

Therefore, related to tree premises already described above, the following equivalence of parameters has demonstrated.

Premises	Benefits Parameters	Aimed improvements	Auxiliary mechanism relation
1st	**Velocity**	1- Reductions of starter velocity of take-off and approach velocity of landing, considering no detriment of lift capability. 2- Increase of cruise velocity without an elevating consumption of fuel.	The both mechanisms are able to support the airfoil in order to decrease the starter velocity and increase the cruise velocity, saving cost due to fuel consumed and reductions of flight time schedule.
2nd	**Wing Area**	Decrease the area needs on wing and airfoil projects in order to allow also the drag force reduction.	On low and high velocities situations the wing and airfoil are able to support the elevate functionality level, considering the adjustment capability of this variability due to the auxiliary mechanisms application that arrange or regulate the lift upward and downwash in order to established the must adequate operational answer of airplane.
3th	**Airfoil Applicability**	A functionality context that allow an elevate maneuverability and operational capability on many scenarios of velocities and airplane situations.	The airfoil design should be allow an adequate balance on low and high velocities, as already mentioned. However, the actual technology conjecture does not allow applying this concept considering the elevate costs joined. However, the auxiliary mechanisms are a rational and low cost options in order to improvement the airfoil operations levels.

In resumed terms, these mechanisms are design in order to aid the flight context due to an increase of lift upward capability aligned with a drag effects reduction. A cost reduction it estimated based on fuel consumption decrease (from the reduction of take-off and landing velocities) with an increase of cruise velocity, which means a paradigm shift over commercial air flights operations.

The following chapter demonstrating the viability of mechanisms in terms of prototyping with a financial-economic study, regarding a return of investment approach.

2 Financial-Economic Viability study

This chapter has the following contents:

- The prototyping as measurement model
- Establishment of gain proposed
- Estimation of Disbursements
- Return of Investment

The prototyping as measurement model

The financial-economic viability study it is related directly to measurement of innovative proprieties presented on proposal, compared to the needs that are used to prototyping an exemplar. Established as well, a simplest relation between the estimated gains (i.e. operational improvements as such as saving costs, already above chapter mentioned) versus the disbursements applied (i.e. material and professionals resources) in order to prototyping and obtaining a serial production, in future terms.

Therefore, any measurement study (i.e. technical and financial) needs to be established a well-delineated and well-defined model considering the parameters of evaluation. Moreover, this models it should be able to be compared with the actual technology standard, regarding the same parameters conceited.

The proposal model has applying the auxiliary mechanisms and the measurement approach occurs using the parameters already defined on last chapter, considering there the precepts of innovative proposal. As following demonstrate:

- Velocity;
- Wing Area;
- Airfoil applicability.

In order to establish the measurements terms of innovative proposal has considered the physical values of flight within and without the auxiliary mechanisms application. Essentially, the physical values of flight related to lift and drag amounts, however the velocity, wing area and airfoil applicability represents the consequence of lift and drag significance over flight context, and regarding the further proposal modeling, also.

From evaluation of this parameters, the modeling proposed aims essentially demonstrate an empirical situation of the possibilities of mechanisms applications (and their deactivation, also), which the viability analysis (i.e. technical on beginning, and financial on posteriors) becomes easier and feasible in order to transcribe and prove the precepts relevance already above described.

Then, the modeling should align a didactical and empirical aims, abstaining of deleterious and unnecessary discussions over the model confection and their phases and activities, and the conception and manufacturing of this model should occurs simplest and objectivist. Therefore, a study involving a complex project that the major aim is demonstrate two mechanisms that aiding the airfoil performance enhancement should not being defocused and allusive of this main objective.

Otherwise, a concern about mechanisms demonstration it related to less representation of practicability, considering the proposal completeness. Therefore, the model to be proposing should concomitant represents the applicability and the viability of auxiliary mechanisms in terms of functional and empirical examples. In this context, the conceptual idea that could represent innovatively the modeling, it is the simplest way of flying: an individual flight.

What, however, the relevant interest in modeling and propose mechanisms in order to improvement the lift and drag effects which is only possible to transport an only individual, and nothing more than flying. Assuming the principle that since the early experimental flights the fascination of flight act determines a series of actions (apparently) inconsistent and difficult to understand, making the individual flying as the singular and most lucid expression while alluding to the human capacity to govern their own evolution. Therefore, the individual whom take-off in usual conditions of weather represents the best technical capacitating in terms of technologic overcoming, and the same time with a relevant symbolism.

Comparing this concept idea with the usual hang-glider, there is not difficult to understand the manifestation of this fascination, considering that the hang-glider such as a flight element with a small contribution on aeronautic technology evolution, considering that for it flying needs special conditions of locations and environment. However is clear there application on several recreation and sportive activities, regarding mostly the flight astonishment.

Therefore the modeling has not proposing a sportive or recreate finality, although it is not also well defined a specific applicability. The main aim of modeling it is developing an experimental air-ensemble able to operate under broad and feasible conditions (e.g. take-off at sea level, no need to use high topologies degree and the rising air currents) with safety and designated to only individual driver.

The following figure demonstrate the proposal of modeling, regarding the major objectives:

- Easy-handling
- High-capacity maneuver
- Non-restrictive use, related to conditions of topography and normal regime of winds

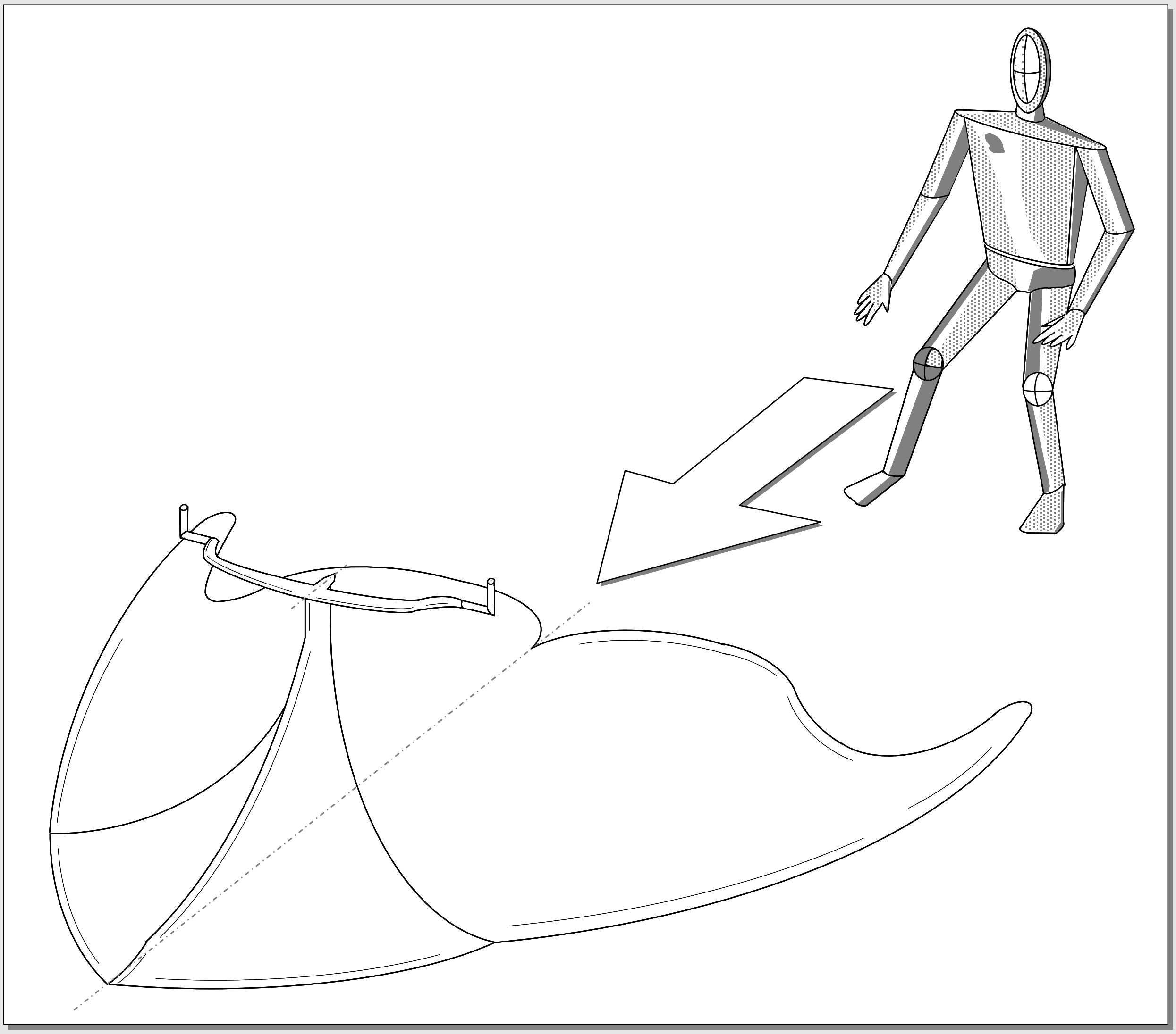


Figure # 6

A differential of this proposal it is exactly establish an experimental prototype in order to allow the both auxiliary mechanisms utilization and being feasible an air-ensemble able to operate on ample conditions of take-off, flying and landing. Considering that, following observed advantages of this prototyping.

- Low cost development and assembly
    - Occurred by the air-ensemble simplicity due to the prototype be composed by only board which the wings joined and then constituting the body with the stalk (aerodynamic shape) to hands backing, perpendicular of longitudinal axis of board body.
    - The prototype manufacturing respect phases (e.g. materials purchase, factory locate and equipments) and techniques (e.g. assembly, wending) well established and disseminated in order to composed the body as well as there is not specially on materials to be used on their constituting, regarding proprieties balance between lightness and relative hardness.
- Low cost of tests analysis, evaluation and examination of prototype (i.e. project and design viability)
    - Structures and dimensional evaluation occurs by computational aided due to software already applied on large scales.

- o Empirical tests occurs with parallel procedures which subsystems of the entire prototype are evaluates, individually. The ensemble test, considering specific structure assessment performed with a single procedure.

- Implicit Demonstration of air-ensemble operability
  - o The results obtained by prototyping represent the immediate demonstration of equipment operability over assembled mechanism and their aid functionalities.
  - o Observe an individual flight due to topography and environmental conditions with no longer restrictions represents already a peculiar aeronautic engineer accomplishment.
  - o Innovative solutions are possible from a simple analysis of cause and effect, and its demonstration as an aeronautic technological.

Establishment of gain proposed:

From considerations defined on earlier chapters wove a series of enunciates, premises and precepts in order to demonstrate a proposal of technological innovation toward prototyping two auxiliary mechanisms represented at specific and peculiar air-ensemble. Invariably, such proposal would not have a significant representation whether is not demonstrated at numerical rational well defined and juxtaposed.

For that, will be used a performance analysis of a specific airfoil profile with and without the auxiliary mechanisms approach. And the airfoil profile NACA 63-009 references the futures analogies and analysis, considering for that the following functional characteristics, as below on table-1:

x (percentage of c)	y (percentage of c)	$(v / V)^2$	v / V	$\Delta v_a / V$
0	0	0	0	3.058
0.55	0.749	0.885	0.941	1.889
0.75	0.906	1.002	1.001	1.647
1.25	1.151	1.051	1.025	1.339
2.5	1.582	1.130	1.063	0.961
5.0	2.196	1.180	1.086	0.689
7.5	2.655	1.205	1.098	0.560
10	3.024	1.221	1.105	0.484
15	3.591	1.241	1.114	0.386
20	**3.997**	**1.255**	**1.120**	**0.324**
25	4.275	1.264	1.124	0.281
30	4.442	1.269	1.126	0.248
35	4.500	1.265	1.125	0.220
40	4.447	1.255	1.120	0.196
45	4.296	1.235	1.111	0.175
50	4.056	1.208	1.099	0.156
55	3.739	1.175	1.084	0.140
60	3.358	1.141	1.068	0.124
65	2.928	1.104	1.051	0.109
70	2.458	1.065	1.032	0.095
75	1.966	1.025	1.012	0.082
80	1.471	0.984	0.992	0.069
85	0.990	0.942	0.971	0.057
90	0.550	0.903	0.950	0.044
100	0	0.838	0.915	0

Table-1: Functional data of NACA 63-009 airfoil profile

Considering that c represents the chord length, v the fluid velocity on any point of airfoil surface, and the V velocity of air in opposition direction of the airfoil. Such table represents the theoretical values of this airfoil profile.

In graphics terms, the content of table-1 represents into following diagram-1:

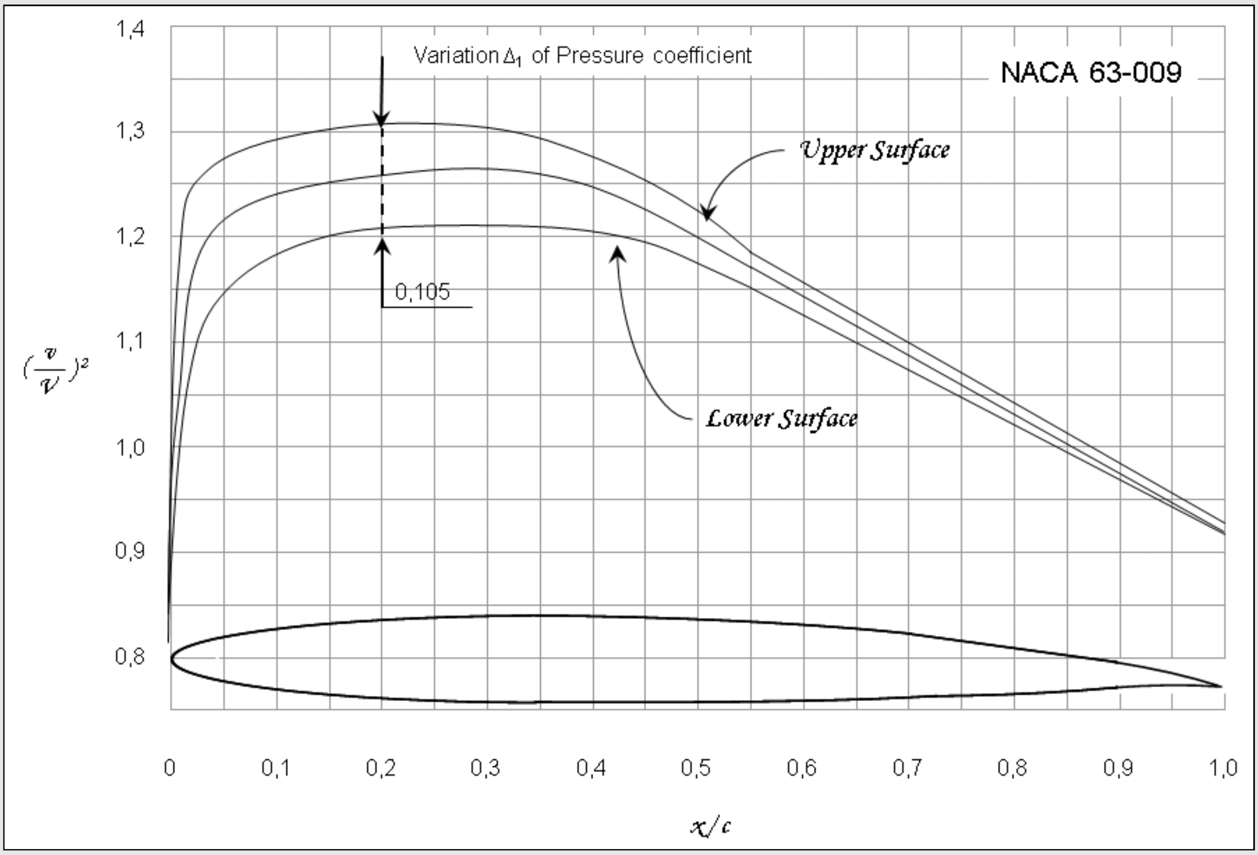


Diagram-1: NACA 63-009 profile Pressure Coefficient variation

Observing the variation Δ_1 of pressure coefficient $\{(v/V)^2\}$ between upper and lower surface this difference represents the capacity of lift that airfoil allows related to their geometry (i.e. angle of attach of 0°).

Evaluation however, the same airfoil profile with auxiliary mechanisms usage considering that the fluid velocity v in lower surface decrease and the velocity of upper surface increase due to the mechanism named "airfoil lift force improvement section" performs. And, also considering the perform of other mechanism named "airfoil trailing edge drag force reduction component" the $\mathcal{V}$ velocity of air gets an increase amount of their value that represents a better performance of airfoil function.

The profile airfoil within auxiliary mechanisms there is the following theoretical result, as demonstrate on diagram-2:

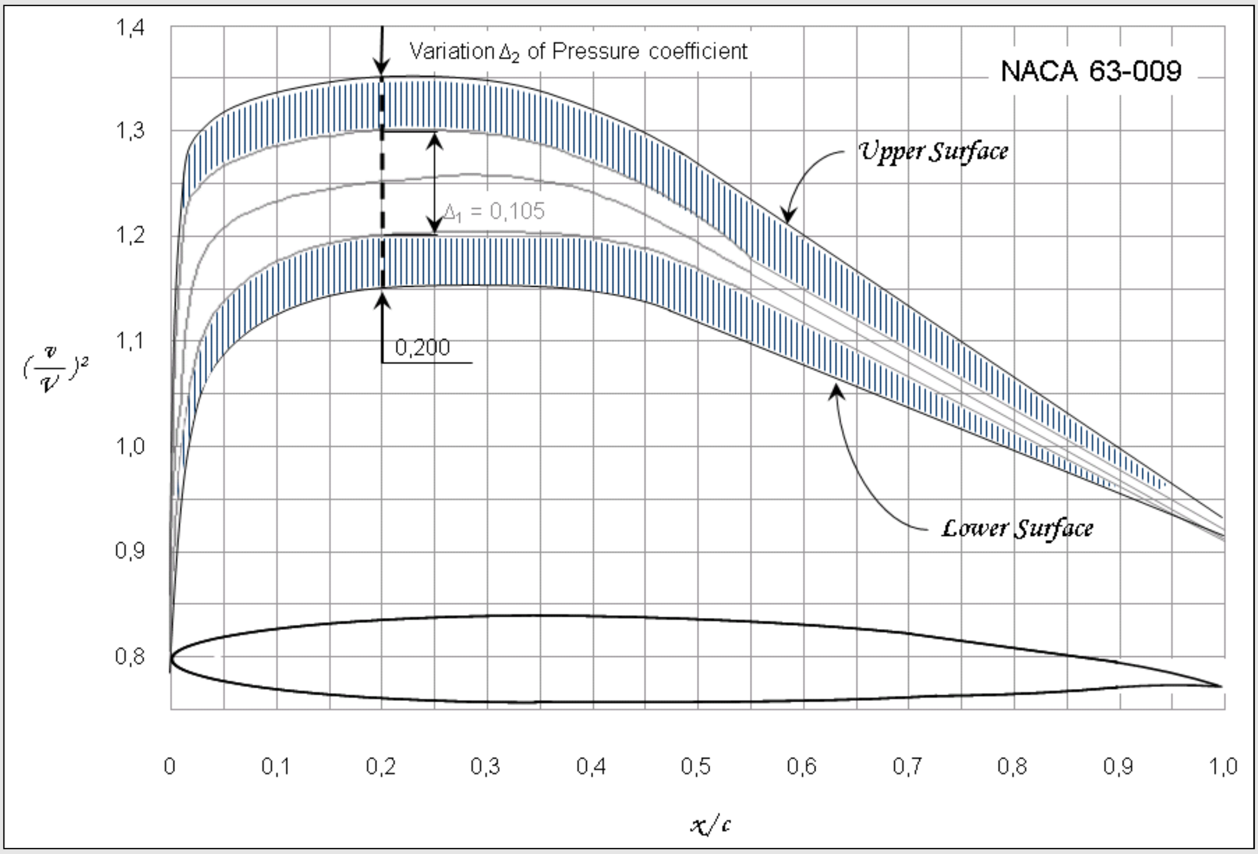


Diagram-2: Range increase of NACA 63-009. Pressure coefficient variation due to auxiliary mechanisms performs

In this diagram, it is observe an operational increase related to range amplitude of pressure coefficient, considering for that the velocity v variation in the upper and lower surfaces. The variation Δ_2 presents an increase of 90%, approximately, over Δ_1, as shown in diagram-2 graphs (e.g. blue highlight). Ever, the pressure coefficient in upper surface, specifically on referential point 0.2 of x/c axis, presents the value of 1.307 without the auxiliary mechanisms effort, and the value of ≈1.350 with mechanisms effects.

It is relevant to mentioning that on upper surface the linear variation is just of 3.25%, and in lower surface the variation noted it is about 4.36%, considering for that the x/c axis in point 0.2 and the pressure coefficient is ≈1.150 with auxiliary mechanisms effort against 1.205 without mechanisms effects over same point of axis.

Therefore, a conclusion it is observed due to the short variations presented on both surfaces of airfoil that causing a significantly increase over total pressure coefficient of profile. This incremental range of pressure coefficient allows consequently the enhancement of lift capability on airfoil profile without geometries and characteristics modifications, just considering the auxiliary mechanisms utilization. Considering for that, the theoretical fact that the minor pressure (velocity v is higher) on upper surface, against a superior pressure (velocity v is smaller) on lower surface.

As demonstrated on figures # 2 and # 4, that the dashed lines distances represents the air-flux (velocity V) over passing around the airfoil than whether some dashed lines distance are greater than others it does mean a smaller pressure location and high velocity v. Otherwise, whether dashed lines distances are less than others it does mean a large pressure location and small velocity v.

Accordingly, the figure-7 demonstrate the dashed lines such as above illustrated (e.g. figures 2 and 4), regarding that the gradient of pressure coefficient it is significantly over sub illustration “b” against “a”, considering the “a” a profile without auxiliary mechanisms, and “b” with auxiliary mechanisms benefits. Observed the $\Delta(v/V)^2$ incremental due to mechanisms effort thus the upper and lower surfaces are adjusted over this benefit obtained.

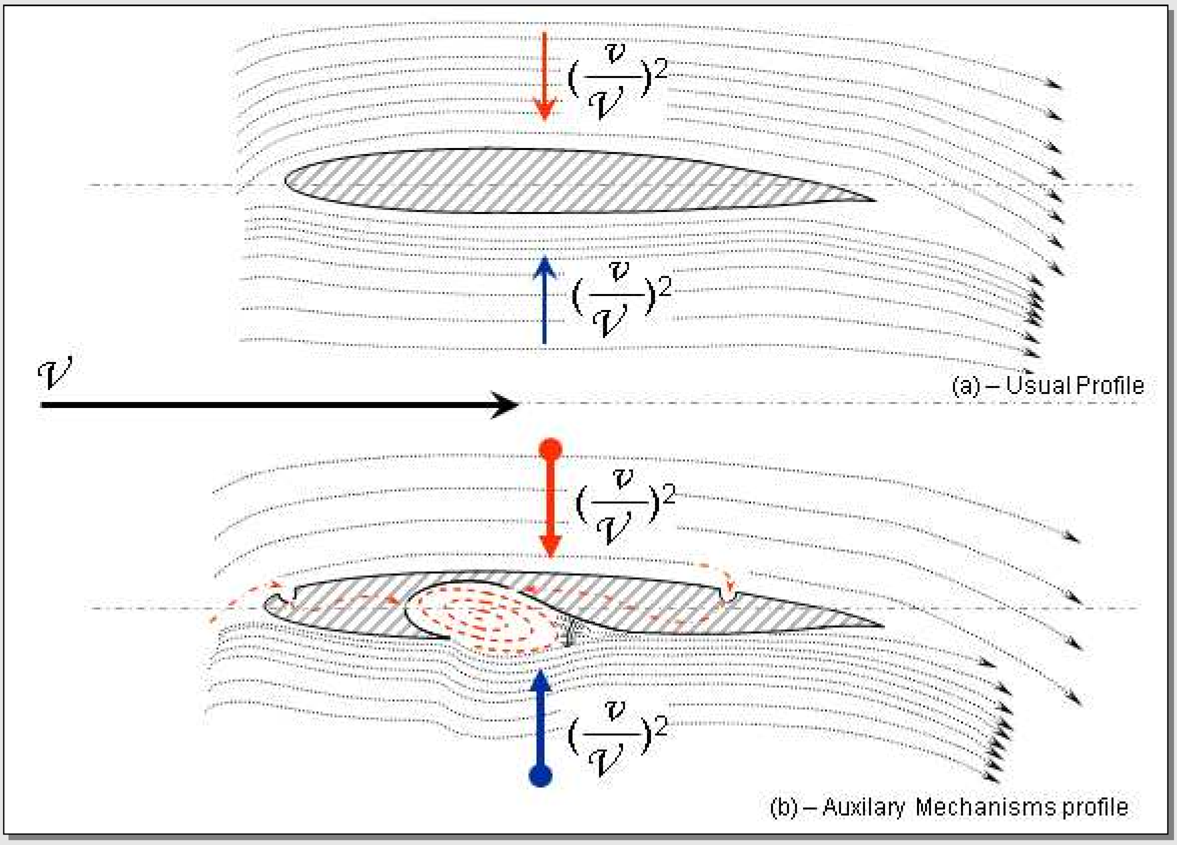


Figure # 7 – Comparative of airfoil lines on velocity V and pressure coefficient between (a) usual profile, and (b) profile with auxiliary mechanisms

Therefore, in order to enunciate the gains proposed the enhancement of 90% of $\Delta(v/V)^2$ (airfoil pressure coefficient variation), represents in practice terms a decrease on operational costs of an airplane. Thus, considering the reduction of velocity V that it is reached by a power system (e.g. propulsion causing by an air-jet or airscrew engine) utilized by airplane, meaning the reduction of airplane power generation and the reduction of fuel consumption, consequently. Otherwise, considering this gain the airplane it is able to transport an over load, compared on normally loaded, causing profitability increases.

The proportion of gains could not be determinate exactly as demonstrated by theoretical $\Delta(v/V)^2$, because the amount of gains does not normally respects a linear correlation. However, it is possible to establish a correlation of specifics benefits due to the precepts already above described. The following table demonstrates the range of possible gains and their concept definitions, considering the auxiliary mechanisms usage.

Precepts	Benefited Parameters	Gains Obtained	Correlated Gains
1st	Velocity	1- Reductions of starter velocity of take-off and approach velocity of landing, considering no detriment of lift capability. 2- Increase of Cruise velocity without elevates fuel consumptions.	1- Reduction of fuel consumption 2- Or, increase of load capacity 3- Operationally increase of airplane, considering a reduction of track length needs for take-off and landing.
		Gain obtained in range of 5% until 15% of investment amount.	The fuel consumption reductions as such the load capability increase, there are not concomitant benefits. Moreover, the return of investment it related to minor value of fuel price or the major profitability recurred of air operations. There is an operationally increase related to increase of possibilities of usage and malleability of airplane with auxiliary mechanisms.
2nd	Wing Area	Decrease the area needs on wing and airfoil projects in order to allow also the drag force reduction.	1- Reduction of design and manufacture costs 2- Reduction of drag effects 3- Reduction of fuel consume of maximums velocity situation.
		Gain obtained in range of 5% until 15% of investment amount.	The reduction in the costs of designing and manufacturing takes place in facilitating and reducing the needs of wing area motivated by the use of auxiliary mechanisms. In addition, the reduction of fuel consumption it is caused by the decrease of drags effects during the cruise flight.
3th	Airfoil Applicability	A functionality context that allow an elevate maneuverability and operational capability on many scenarios of velocities and situations of airplane.	1- Cost Reduction on research and development activities related to profiles and wings designs. 2- Increase related to operational range of profile, allowing an enhancement over possibilities of application as well as low and high velocities and variable angle of attack. 3- Optimization of resources related to flight operation due to amplitude increased of settable function.
		Gain obtained in range of 5% until 10% of investment amount.	Considering the use of auxiliary mechanisms the operational amplitude, it is largest in order to allow a better applicability of airfoil, causing a simplification on processes of research, design and development of this air component.

The amounts of gains already demonstrated on above table represents estimative related to simply analysis of costs of flight operations, considering the numerical rational that will be better explained on next chapter. Thus, the reductions of take-off, cruise and landing velocities causing a decrease of operational costs or an increase of load capacity and profit enhancement, consequently.

In both possibilities that determining the viability and financial return of auxiliary mechanisms investment, depend of flight scales for fuel consumption and other parameters related to load profitability. For that, there is a range of gains hitch to investment amount, getting the return of investment defined as payback fee, as demonstrated in the following sequence.

Estimation of Disbursements:

In this chapter, considering the already explanation of prototyping and the gains proposed, it is necessary an explanation that determining the disbursements estimative related to demonstrate the benefits of auxiliary mechanisms. The major aim of this project related to prototyping a model that allow an individual flight, demonstrating the benefits and the inedited functions involved on auxiliary mechanisms usage. This benefits are related to upwards lift capability, moreover the reduction of drag effects that both aligned benefits allow a tremendous reductions of velocities involved on flight operation (e.g. take-off, cruise and landing velocities requirements), and an increase of airfoil applicability allowing a simplest designation for use due to the settable capability inherent at auxiliary mechanisms.

The consequence of this technical benefits it is the cost reduction of flight operations, because minor velocities requested causing a proportional (it is not necessarily linear relation) reduction of fuel consumed.

Therefore, the disbursements related to demonstration of these benefits as a modeling prototype project are explained on following program (stages and phases) of activities.

Project Phases and Estimate of hours consumed (3,060 hours)

1-	**Definition**		**495 hours**
	1-1	Final proposal inherent at Technological Innovation, contending the premises and precepts minimal requested to forward the prototyping;	75 hours
	1-2	Preparation and captivate the resources needs such as structural and human (i.e. equipments - computers, machinery, office, etc – software licenses, physical location, budge and professionals involved – direct and indirect);	225 hours
	1-3	Bibliographical references and theoretical;	25 hours
	1-4	Engineer and Values Analysis – establishment of activities schedule, methodologies applied, conceptual approach and innovative concepts;	150 hours
	1-5	Legal activities related to agreement terms, statutory, laws compliance, patents and copyright inherent at project.	20 hours
2-	**Planning and Design**		**875 hours**
	2-1	Calculation Memorial of project;	175 hours
	2-2	Detailed design of project components;	200 hours
	2-3	Assembly design;	125 hours
	2-4	Previous definition of materials usage and dimensioning;	150 hours
	2-5	Simulation (functionally and structurally) of full project and components aided by computational software.	225 hours
3-	**Execution**		**470 hours**
	3-1	Ratification of the phases of prototyping;	50 hours
	3-2	Ratification of the quantity to be manufacture;	10 hours
	3-3	Prototype preparation, regarding the all project considerations;	360 hours
	3-4	Prototype final ratification	50 hours
4-	**Tests and Validation**		**970 hours**
	3-1	Physical examination (e.g. structural) of components;	150 hours
	3-2	Physical examination of ensemble assembled;	360 hours
	3-3	Tests of functionally validation (i.e. aerodynamics and performance);	360 hours
	3-4	Resistance test, and destructive examination of main components.	100 hours
5-	**Final Implementation**		**250 hours**
	3-1	Full physical test of real situation of use and handling;	125 hours
	3-2	Homologation of prototype / project;	75 hours
	3-3	Final report / article preparation, considering also specialized media dissemination and communication.	50 hours

Considering the phases above described and the time schedule estimated, the amount of 3,060 hours represents the total of dedication in order to development and concept a prototype with innovative technologies.

The disbursement of project it is directly associated with this estimate amount of hours. However, the total value of disbursements alternate as according to professionals employed, equipments applied, location or research place and other costs related to accomplishment of research and development activities, observing the cost definition as direct and indirect costs.

Considering this fact, and in order to pricing this project the financial model to be adopted is defined as fee project that meaning multiply the total amount of hours per a monetary value, representing the total cost of project / prototype. Such fee project already included the direct costs (e.g. professionals involved, equipments rented, computers, software licenses, location, etc) and some indirect costs, which this costs are easily defined (e.g. accountability personal support or general administration, maintenance, IT support, etc). This model it is applied on vary trades negotiations, considering the diversification of scopes and acting areas (e.g. advisory and consulting marketing, third part services), make feasible the cost structure of all operations and activities involved in this project.

Based on this cost model, and verifying the average on technical consulting market, the value of project fee needs to contemplate the human and material complexity with the schedule and parallel activities of prototyping project. Thus, considering these factors the value initial proposed it is USD 300.00, causing the total cost of project at USD 918,000.00.

Return of Investment:

Along the chapter 2 the explanations of financial-economics analysis occurs through the proposal measurement due to prototyping and the estimate establishment of gains and disbursements.

Considering that, the final and feasible explanation able to be contained in this chapter refers to relating the gains and disbursements on concept of return of investment, determining a payback rational.

The concept to calculate the payback it is very simple, establishing the apportionment of the amount of gain relative to the amount invested. This relation denotes at return rate that demonstrate the capacity of project and their benefits in capitalize monetary amounts as gains returned to the investor, determining whether the project attempts in financial terms to the socioeconomics context. For example, a return rate of 25% during a determinate period represents that for each USD 1 invested the return is 25 cents, and the payback represents the period that the investor returned the full investment, in this example the same USD 1. In addition, for a comprehension whether a return rate it is significant or interesting it is necessary to understand the current socioeconomics context, in order to apply an investor point of view, balancing the risk involved and the profitability possible to be reach.

Based on, the socioeconomics context and risk involved are two concepts that deserve a better understand of their correlation with financial viability of this innovative project. Thus, the business environment depends of macroeconomics scenarios that determines the inclination of more or less innovative initiatives, considering this scenarios an equivalence of profitability average level, and the socioeconomics context represents the common situation related to this scenarios, meaning that a high activities of jobs and business or the inverted of this.

In addition, the risk involved represents the concept of “risk appetite” it is also applied to determinate the viability of project, considering the risk associated to profit or return. The consummation of risk could represent the extreme of investment amount loss or a simple delay on project schedule.

Both concepts, the risk associated and socioeconomic context that will induce the decision of invest our not invest at a project with a specific return rate, because the significance of this rate it is directly dominate by this both concepts.

Based on, it is necessary estimate the return rate, considering the already described tree precepts, as following:

- 1st Precept: reduction of velocities of take-off, cruise and landing;
- 2nd Precept: wing area reduction;
- 3th Precept: increase of Airfoil Applicability.

Due to this precepts the return rate it is determinate by the gains obtained on flight operations, considering the following costs:

- Reduction of fuel used;
- Increase of load capacity (that it is not concomitant of above element);
- Increase of operational range of an airplane;
- Reduction of airplane design and maintenance.

In order to establish a calculatedly rational based on the above premises, considering the profile NACA 63-009 described on subchapter "Establishment of gain proposed" that an increase of 90% on ∆ pressure coefficient. In addition, considering another profile of NACA 63 series the behavior of 63-009 with the auxiliary mechanisms it is similar of 63-012. Thus, regarding this analogy the performance of NACA 63-009 in terms of lift upwards it is about 75% upper related to same profile without the auxiliary mechanisms, as demonstrated below.

NACA 63 series	Lift Coefficient	Up Variation
012	0,14	↑ 75%
009	0,08	

Based on, the following diagram-3 demonstrate the both profiles and the possible analogy of performance their coefficient of pressure.

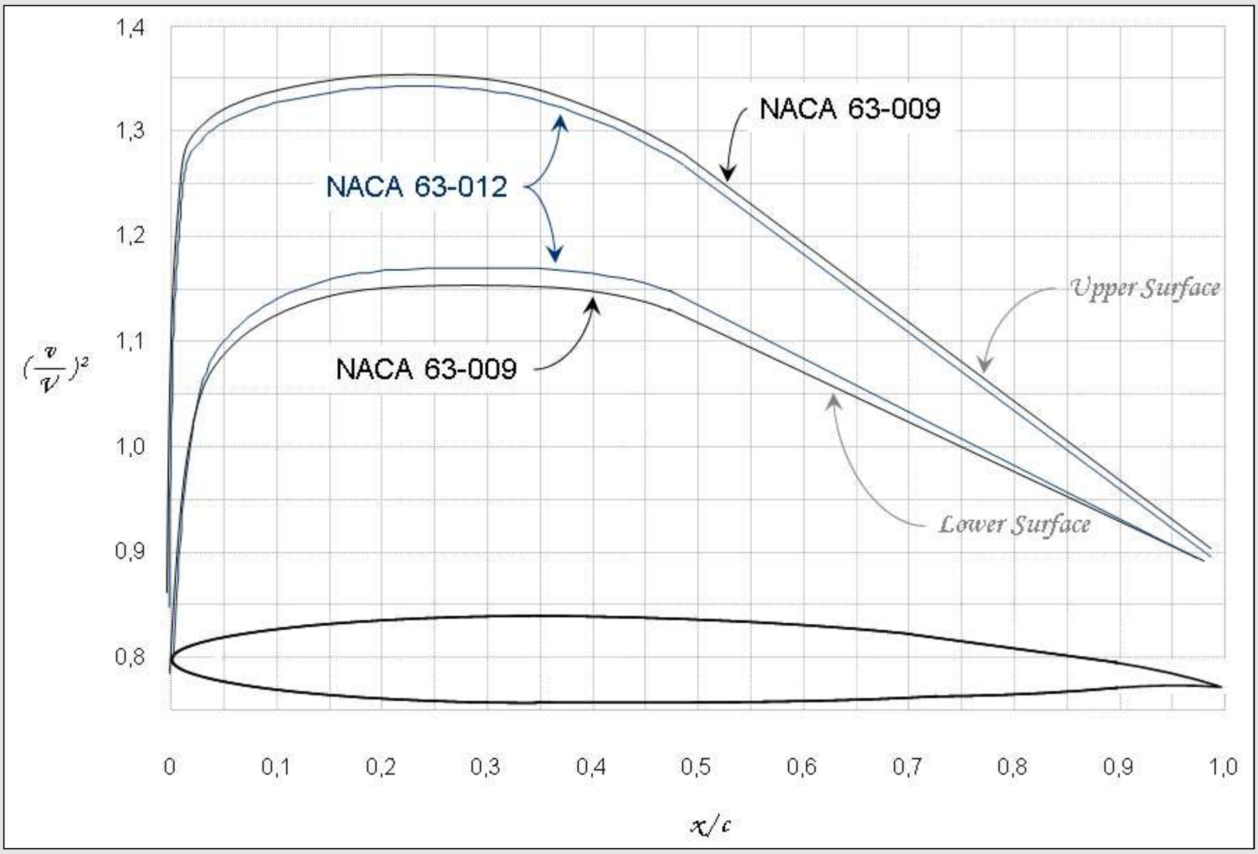


Diagram-3: Comparison between profiles (a) NACA 63-012 e (b) NACA 63-009 (with the auxiliary mechanisms support)

The association utilized and demonstrated in diagram above it is feasible due to the similarity of the curves (e.g. NACA 63-009 and NACA 63-012), considered. Both profiles presents a low worth of lift coefficient, however an increase of 75% determine a relevant reference about the auxiliary mechanisms capability over improvements gains, regarding this increase a reference just applied in related and analyzed profiles. However, this amount meaning the importance and potentially of this mechanisms usage, applying this increase gradient as calculating reference, even estimate that this 75% it is not settable to be theoretical reach in other circumstances (e.g. profiles that there are not a reference of analogy).

Thus, considering the correlation over the worth of incremental lift coefficient due to the linear characteristic of lift formula (see again below), the resultant lift force obtained the same incremental of 75% and, consequently, the reduction of velocity it is about 25%. Also considering, a preliminary and simply research over fuel consumption, the average cost related to fuel it is about 40% of total cost related to operating the airplane flight.

$$L = C_l \times \tfrac{1}{2} \times \rho \times V^2 \times A$$

L ⇨ *Lift*
C_l ⇨ *Coefficient of Lift*
ρ ⇨ *Air Density*
V ⇨ *Velocity*
A ⇨ *Wing Area*

Associating both worth (e.g. velocity reduction of 25% and fuel consumed participation of 40% over total operational cost) it is able to observe a nominal reduction of 10% of fuel consumption. Considering that and observe the following diagram, verified the most relevant fuel consumption occurs on airplane operational step of taxiing and take-off compared on other steps such as fuel consumption of cruise and landing. The fact easily evidenced considering the step of take-off the power applied it is significance in order to upward dislocating the entirety mass to flight, causing an extremely lift capability requirement.

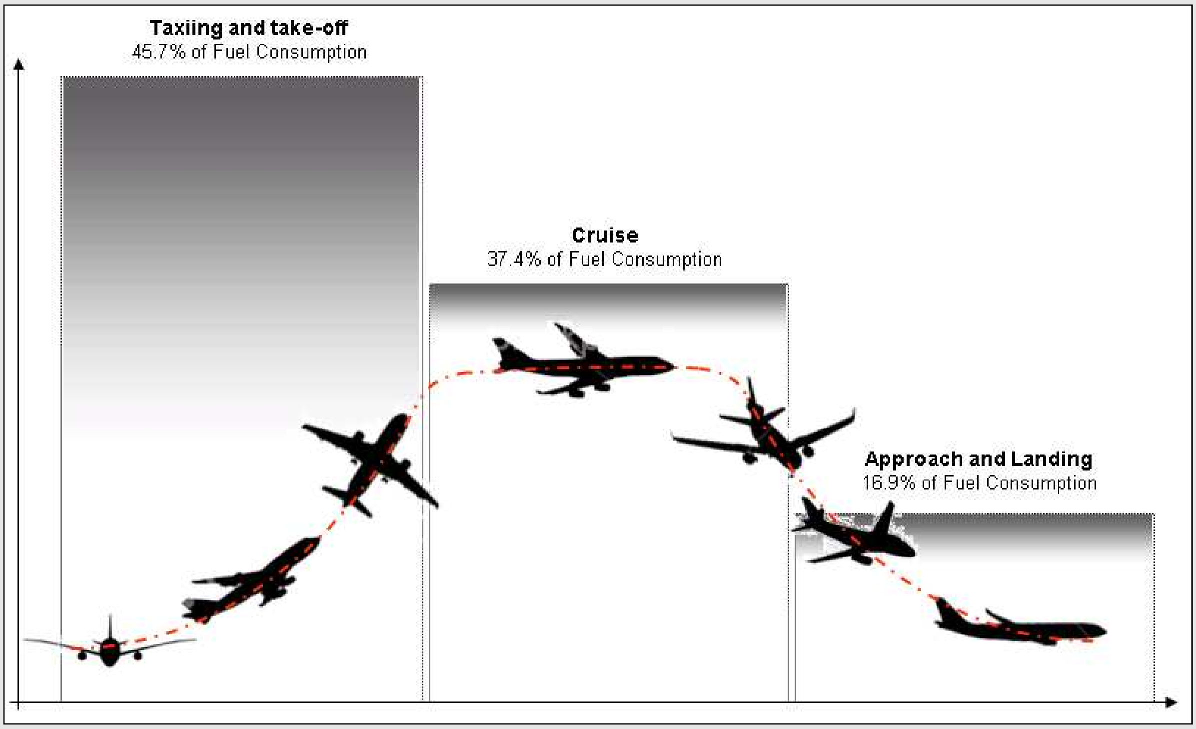


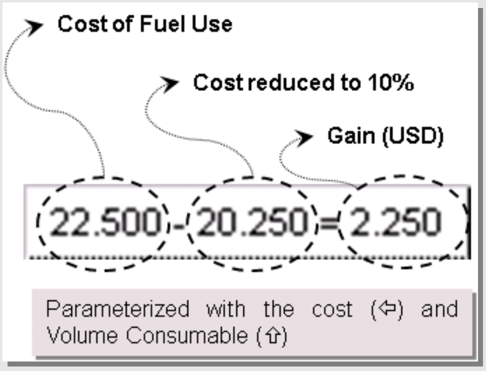
Diagram-4: Schematic representation of fuel consumption for each operational air-flight steps

The auxiliary mechanisms support essentially all steps of operational flight, considering the increase of lift upward and the decrease of drag effects, causing a general fuel consumption reduction that compared with the devices (e.g. Slats or Flaps) actually applied just on take-off and landing procedures.

Thus, considering this global fuel consumption reduction, allowing a cost decrease in all operational steps of flight, the following table demonstrating the gains range obtained by the relation by fuel cost and the fuel consumption, regarding the auxiliary mechanisms full usage. The table information demonstrates the price of fuel (USD) compared on the liters (L) consumption. The aim of this table of contents it is demonstrate the possibilities of savings regarding the fuel price consumption altering.

Then, the reduction of fuel consumption respect a time-basis specific to each air-flight operation characteristic, considering the volume consummated of fuel could be defined for a week, a month or a day related to air-flight operation, causing by one or more airplanes or quantity of flights involved. In addition, the fuel price could be altering for any reasons involved on socioeconomic context such as market restriction of demand, international crises involved to oil market and supply and demand unbalanced. Moreover, the fuel applied presents a variation related to airplane and propulsion characteristics. This fuel variation represents itself an altering on fuel prices and consumption, depend of the fuel type such as Aviation fuel - jet fuel or Avgas - aviation gasoline.

Considering so, this context of variation (e.g. fuel characteristics, price and volume consumption) the table below considering the following pattern for demonstrating the potential gains.



The following tables demonstrates the relation of savings over the fuel consumption (Liter) and fuel price (USD):

		Table - Volume Consumable (Liters)							
		15,000	20,000	30,000	40,000	50,000	100,000	200,000	300,000
Unit Cost (USD)	0.75	30.000 - 27.000 = 3.000	37.500 - 33.750 = 3.750	75.000 - 67.500 = 7.500	150.000 - 135.000 = 15.000	225.000 - 202.500 = 22.500	30.000 - 27.000 = 3.000	37.500 - 33.750 = 3.750	75.000 - 67.500 = 7.500
	0.85	34.000 - 30.600 = 3.400	42.500 - 38.250 = 4.250	85.000 - 76.500 = 8.500	170.000 - 153.000 = 17.000	255.000 - 229.500 = 25.500	34.000 - 30.600 = 3.400	42.500 - 38.250 = 4.250	85.000 - 76.500 = 8.500
	0.95	38.000 - 34.200 = 3.800	47.500 - 42.750 = 4.750	95.000 - 85.500 = 9.500	190.000 - 171.000 = 19.000	285.000 - 256.500 = 28.500	38.000 - 34.200 = 3.800	47.500 - 42.750 = 4.750	95.000 - 85.500 = 9.500
	1.00	15,000-13,500=1,500	20,000-18,000=2,000	30,000-27,000=3,000	40,000-36,000=4,000	50,000-45,000=5,000	100,000-90,000=10,000	200,000-180,000=20,000	300,000-270,000=30,000
	1.05	15,750-14,175=1,575	21,000-18,900=2,100	31,500-28,350=3,150	42,000-37,800=4,200	52,500-47,250=5,250	105,000-94,500=10,500	210,000-189,000=21,000	315,000-283,500=31,500
	1.10	16,500-14,850=1,650	22,000-19,800=2,200	33,000-29,700=3,300	44,000-39,600=4,400	55,000-49,500=5,500	110,000-99,000=11,000	220,000-198,000=22,000	330,000-297,000=33,000
	1.15	17,250-15,525=1,725	23,000-20,700=2,300	34,500-31,050=3,450	46,000-41,400=4,600	57,500-51,750=5,750	115,000-103,500=11,500	230,000-207,000=23,000	345,000-310,500=34,500
	1.20	18,000-16,200=1,800	24,000-21,600=2,400	36,000-32,400=3,600	48,000-43,200=4,800	60,000-54,000=6,000	120,000-108,000=12,000	240,000-216,000=24,000	360,000-324,000=36,000
	1.25	18,750-16,875=1,875	25,000-22,500=2,500	37,500-33,750=3,750	50,000-45,000=5,000	62,500-56,250=6,250	125,000-112,500=12,500	250,000-225,000=25,000	375,000-337,500=37,500
	1.30	19,500-17,550=1,950	26,000-23,400=2,600	39,000-35,100=3,900	52,000-46,800=5,200	65,000-58,500=6,500	130,000-117,000=13,000	260,000-234,000=26,000	390,000-351,000=39,000
	1.35	20,250-18,225=2,025	27,000-24,300=2,700	40,500-36,450=4,050	54,000-48,600=5,400	67,500-60,750=6,750	135,000-121,500=13,500	270,000-243,000=27,000	405,000-364,500=40,500
	1.45	21,750-19,575=2,175	29,000-26,100=2,900	43,500-39,150=4,350	58,000-52,200=5,800	72,500-65,250=7,250	145,000-130,500=14,500	290,000-261,000=29,000	435,000-391,500=43,500
	1.75	26,250-23,625=2,625	35,000-31,500=3,500	52,500-47,250=5,250	70,000-63,000=7,000	87,500-78,750=8,750	175,000-157,500=17,500	350,000-315,000=35,000	525,000-472,500=52,500
	2.00	30,000-27,000=3,000	40,000-36,000=4,000	60,000-54,000=6,000	80,000-72,000=8,000	100,000-90,000=10,000	200,000-180,000=20,000	400,000-360,000=40,000	600,000-540,000=60,000
	2.50	37,500-33,750=3,750	50,000-45,000=5,000	75,000-67,500=7,500	100,000-90,000=10,000	125,000-112,500=12,500	250,000-225,000=25,000	500,000-450,000=50,000	750,000-675,000=75,000
	3.00	45,000-40,500=4,500	60,000-54,000=6,000	90,000-81,000=9,000	120,000-108,000=12,000	150,000-135,000=15,000	300,000-270,000=30,000	600,000-540,000=60,000	900,000-810,000=90,000
	3.50	52,500-47,250=5,250	70,000-63,000=7,000	105,000-94,500=10,500	140,000-126,000=14,000	175,000-157,500=17,500	350,000-315,000=35,000	700,000-630,000=70,000	1,050,000-945,000=105,000
	4.00	60,000-54,000=6,000	80,000-72,000=8,000	120,000-108,000=12,000	160,000-144,000=16,000	200,000-180,000=20,000	400,000-360,000=40,000	800,000-720,000=80,000	1,200,000-1,080,000=120,000

Unit Cost (USD)	Table continued - Volume Consumable (Liters) 500,000	750,000	1,000,000	1,500,000	2,500,000	3,000,000	3,500,000
1.00	500,000-450,000=50,000	750,000-675,000=75,000	1,000,000-900,000=100,000	1,500,000-1,350,000=150,000	2,500,000-2,250,000=250,000	3,000,000-2,700,000=300,000	3,500,000-3,150,000=350,000
1.05	525,000-472,500=52,500	787,500-708,750=78,750	1,050,000-945,000=105,000	1,575,000-1,417,500=157,500	2,625,000-2,362,500=262,500	3,150,000-2,835,000=315,000	3,675,000-3,307,500=367,500
1.10	550,000-495,000=55,000	825,000-742,500=82,500	1,100,000-990,000=110,000	1,650,000-1,485,000=165,000	2,750,000-2,475,000=275,000	3,300,000-2,970,000=330,000	3,850,000-3,465,000=385,000
1.15	575,000-517,500=57,500	862,500-776,250=86,250	1,150,000-1,035,000=115,000	1,725,000-1,552,500=172,500	2,875,000-2,587,500=287,500	3,450,000-3,105,000=345,000	4,025,000-3,622,500=402,500
1.20	600,000-540,000=60,000	900,000-810,000=90,000	1,200,000-1,080,000=120,000	1,800,000-1,620,000=180,000	3,000,000-2,700,000=300,000	3,600,000-3,240,000=360,000	4,200,000-3,780,000=420,000
1.25	625,000-562,500=62,500	937,500-843,750=93,750	1,250,000-1,125,000=125,000	1,875,000-1,687,500=187,500	3,125,000-2,812,500=312,500	3,750,000-3,375,000=375,000	4,375,000-3,937,500=437,500
1.30	650,000-585,000=65,000	975,000-877,500=97,500	1,300,000-1,170,000=130,000	1,950,000-1,755,000=195,000	3,250,000-2,925,000=325,000	3,900,000-3,510,000=390,000	4,550,000-4,095,000=455,000
1.35	500,000-450,000=50,000	750,000-675,000=75,000	1,000,000-900,000=100,000	1,500,000-1,350,000=150,000	2,500,000-2,250,000=250,000	3,000,000-2,700,000=300,000	3,500,000-3,150,000=350,000
1.45	525,000-472,500=52,500	787,500-708,750=78,750	1,050,000-945,000=105,000	1,575,000-1,417,500=157,500	2,625,000-2,362,500=262,500	3,150,000-2,835,000=315,000	3,675,000-3,307,500=367,500
1.75	550,000-495,000=55,000	825,000-742,500=82,500	1,100,000-990,000=110,000	1,650,000-1,485,000=165,000	2,750,000-2,475,000=275,000	3,300,000-2,970,000=330,000	3,850,000-3,465,000=385,000
2.00	575,000-517,500=57,500	862,500-776,250=86,250	1,150,000-1,035,000=115,000	1,725,000-1,552,500=172,500	2,875,000-2,587,500=287,500	3,450,000-3,105,000=345,000	4,025,000-3,622,500=402,500
2.50	600,000-540,000=60,000	900,000-810,000=90,000	1,200,000-1,080,000=120,000	1,800,000-1,620,000=180,000	3,000,000-2,700,000=300,000	3,600,000-3,240,000=360,000	4,200,000-3,780,000=420,000
3.00	625,000-562,500=62,500	937,500-843,750=93,750	1,250,000-1,125,000=125,000	1,875,000-1,687,500=187,500	3,125,000-2,812,500=312,500	3,750,000-3,375,000=375,000	4,375,000-3,937,500=437,500
3.50	650,000-585,000=65,000	975,000-877,500=97,500	1,300,000-1,170,000=130,000	1,950,000-1,755,000=195,000	3,250,000-2,925,000=325,000	3,900,000-3,510,000=390,000	4,550,000-4,095,000=455,000
4.00	675,000-607,500=67,500	1,012,500-911,250=101,250	1,350,000-1,215,000=135,000	2,025,000-1,822,500=202,500	3,375,000-3,037,500=337,500	4,050,000-3,645,000=405,000	4,725,000-4,252,500=472,500

Therefore and as mentioned the global saving measurement depends of volume and price of fuel used. Thus, in order to establish an effective return rate of investment and considering the elevate variables involved as above demonstrated, an analysis based on defined scenarios regards both parameters (price and volume) that combined situations of low, middle and high volume and price establishment.

1st Scenario – Payback Calculation – Low Return

- **Investment**:
  USD 500,000.00
- **Opportunity of Gain**:
  USD 8,750.00
- **Return rate**:
  1.75%
- **Period for Return**:
  57.41 months

Notes:

- The amount invested refers to the value applied in order to adjust the auxiliary mechanisms into air-ensemble(s) that consuming the fuel volume, respectively.
- The gain demonstrated refers to 50,000 liters of consumed fuel volume and the price of USD 1.75, considering a monthly period.
- The investment returns occurs at five years, approximately.
- Emphasized that this scenario does not considered the investment of USD 918,000.00 related to innovative proposal prototyping, considering the fact that this amount incorporates a specific scenario that it is before the implementation stage of this technology.

2nd Scenario – Payback Calculation – Middle Return

- **Investment**:
  USD 800,000.00
- **Opportunity of Gain**:
  USD 105,000.00
- **Return rate**:
  13.13%
- **Period for Return**:
  7.62 months

Notes:

- The gain demonstrated refers to 300,000 liters of consumed fuel volume and the price of USD 3.50, considering a monthly period.
- The investment returns occurs less than one year.
- The amount invested refers to the value applied in order to adjust the auxiliary mechanisms into air-ensemble(s) that consuming the fuel volume, respectively.
- Emphasized that this scenario does not considered the investment of USD 918,000.00 related to innovative proposal prototyping, considering the fact that this amount incorporates a specific scenario that it is before the implementation stage of this technology.

3th Scenario – Payback Calculation – High Return

- **Investment**:
  USD 2,300,000.00
- **Opportunity of Gain**:
  USD 450,000.00
- **Return rate**:
  19.57%
- **Period for Return**:
  5.11 months

Notes:

- The gain demonstrated refers to 1,500,000 liters of consumed fuel volume and the price of USD 3.00, considering a monthly period.
- The investment returns occurs less than half year.
- The amount invested refers to the value applied in order to adjust the auxiliary mechanisms into air-ensemble(s) that consuming the fuel volume, respectively.
- Emphasized that this scenario does not considered the investment of USD 918,000.00 related to innovative proposal prototyping, considering the fact that this amount incorporates a specific scenario that it is before the implementation stage of this technology.

Easily observed, that whether increasing the operational scale the return rate it is proportionally elevated. Based on, the scenarios already described could represent a single air-flight operation as such as air fleet operations, considering the last one situation as necessary an elevated investment in order to adapt the airplanes with auxiliary mechanisms.

Other relevant element in this equation refers to fuel price establishment, causing by international geographic-economics factors that denotes the oil price variability, regarding the predictability of this factors extremely difficult and imprecisely.

In addition, the tree scenarios represents a simply approach focused in demonstrated the possibilities of gains due to an established saving of 10% related to fuel consumption. However, this analysis represents a conservator approach regards the theoretical situations of proposal (auxiliary mechanisms) and their results as such improvement equipments of airplane or any air-ensemble.

Based on, in order to finalize this rational calculation the same approach of return rate of investment is applied related to prototype phase that as already mentioned require an amount of investment due to demonstrate the auxiliary mechanisms in working situation. Considering the following result, the same could be uses as complement related to tree scenarios above demonstrated. Moreover, the following table has not considering into scenarios calculation, because there is realized on distinctive phases.

Payback Calculation – Prototyping	
o **Investment**: USD 1,055,700.00 o **Opportunity of Gain**: USD 115,000.00 o **Return rate**: 10.89% o **Period for Return**: 9.18 months	**Notes**: ▪ The amount of investment refers to the value of prototyping (described on chapter *Estimation of Disbursements* on page 17 about USD 918,000.00) added an error margin of 15%. ▪ The return of investment represents the viability of commercialization regarding the auxiliary mechanisms, considering the return rate related to global saving of fuel adjusted. ▪ The respectively adaptation of mechanisms into airplanes or air-ensemble there are transcribed on each scenario analysis.

Therefore, there are manifold and promising possibilities of returns considering the global saving related to this innovative proposal. The commercialization of this technology implicates to establish a clear methodology in order to allow the adaptation and assembly of auxiliary mechanisms in many airplanes or air-ensembles, regarding the altering sizes and engine applied trough aeronautic civilian market.

This presumption is the utmost relevance and importance considering the return rate which the table “unit cost versus fuel consumable” as rational calculation. Such table demonstrates the many possibilities or combinable arrangements that denotes by analogy the variability related to socio-economic air-market in terms of cost (at least a portion of total cost related to operational air-flights). And so, considering the notoriously situation of air-market that it is composed by many type of companies from many countries with different types of air-planes, establishing the possibility of assembly for adapt any kind of airplane within auxiliary mechanisms the success variable of this project it is enhancement.

Evidently, a group of devices proposing the modification of lift upward capability there are effectively better composed and understood whether the same mechanisms has considered in entire design phases. Moreover, a modification with in-use airplane represents a concern of the manufacturer or maintainer. However, the following topics demonstrate a proposal of auxiliary mechanisms adaptation and assembly:

- The physical structure (e.g. airplane or air-ensemble) it is minimal request to be changed, considering the auxiliary mechanisms installation, specifically regards the wings structure.
- Moreover, the auxiliary mechanisms does not need to be installed in wing structure, because it is possible to be assembly in a diminutive and special set of wings joined only regarding the establishment of auxiliary mechanisms.
- The auxiliary mechanisms operation there are extremely simplified that does not requiring any extra power from engines.
- An eventually shutdown of auxiliary mechanisms does not represents any concern of reliability or commitment, regarding the airplane or air-ensemble global operative capability.
- The auxiliary mechanisms installation and assembly considerer a detailed and specific study, analysis and projecting for any kind of airplane, regarding their specifications and flight conditions usage.

Therefore, the 2nd chapter finalization represents the overview related to prototyping, disbursements, investment return estimative and the establishment of economic-financial viability proposal.

3 Final Conclusion

The conceptual context already above explained essentially aims the proposal demonstration and the project initially structured from a lucubration of two mechanisms that allow innovative possibilities of add upward lift and drag reducing regarding airfoil functionality.

Such proposal represents an innovative ideas of improvement related to aerodynamic performance that any airfoil could be able to increase the lift upward and also decrease the drag effects, during take-off, cruise and landing operations. The ideas derive from the possibilities to manipulate the airflow along the wing length in order to increase the pressure gradient of airfoil (e.g. reduce the pressure coefficient on upper surface and increase on lower surface, simultaneously), and reduce the drag effect due to annulations of vortices formation. Based on, the main innovative ideas related to this proposal are described below:

- Possibilities to establish the auxiliary settable mechanisms in order to aid the flight parameters of performance (e.g. lift upward and drag effects).
- Auxiliary mechanisms usage, considering their application independently of flight operation as such as take-off, cruise and landing.
- Innovate at airfoil conception, regarding the use of dynamic secondary airflow inside of wing structure, adjusting the pressure and flow relations in order to increase the lift upward and reduce the drag effects.
- Paradigm breaks, considering the proposal of innovation at aerodynamic of airfoil and their functionally.

Otherwise, the major idea of this proposal it related to results of auxiliary mechanisms usage that causing a better financial performance of flight operations. The financial performance it described by two major possibilities that does not concomitant itself to occurs into flight operation, as following:

- Cost reduction deriving from fuel consumption decrease, and;
- Increase the profitability deriving from enhancement of load capacity.

Based on, considering the possibilities not completely concomitant, the better financial result it related to social-economic context that determines the most feasible situation over prices, costs and volumetric of flight operations.

However, in order to determine a financial analysis of this proposal, decided for the fuel consumption option because the same demonstrated the most feasible due to represents a significant part of cost composition of operation flights and an extensive capillarity regarding the commercial flight context, independently of operation bearing.

Thus, from a previous and simplest research that identified the average of fuel consumption represents 40% related to air operation total cost. In addition, this research signalized that in some cases the fuel consumptions reaches the amount of 60%, specifically on commercial passenger transport. However, considering a conserver approach of this proposal, the amount of 40% of fuel cost participation it utilized in order to established the memorial of calculation.

The gain related to 10% reduction of fuel consumption it is an estimative based on calculation of 4.36% increase of pressure coefficient on lower surface, and the reduction of 3.25% on upper surface, respectively, causing an enhancement of 90% of airfoil pressure coefficient. That represents an increase of 75% over lift coefficient due to the auxiliary mechanisms application as such as an improvement element of lift upward on airfoil.

Considering that an estimative, effected by a specific calculation methodology, the gains amounts could be demonstrate by a table using the volume and price variations of fuel as parameter, allowing a better understanding of gains considering the scale of fuel usage. However, this calculation also represents a conservative approach, regarding the needs of a complete understanding of mechanisms functionary over aerodynamics variability.

Evidently, considering that a purely theoretical calculation, it is uncertain behavior of the auxiliary mechanisms under various aerodynamic and environment conditions. Specifically the understanding about airflow displacement of airfoil surfaces behavior, regarding the auxiliary mechanisms usage. However, the auxiliary mechanisms suggest an interesting situation and promising in order to implementation of several air operations, representing an innovative way of improving performance results, since practical studies are required to confirm the operational feasibility of this proposal.

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