Chapter 7 / Capítulo 7

Sustainable balance between usability and aesthetics in hardware and software design within the organizational context
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Impact of technological design on business competitiveness

Impacto del diseño tecnológico en la competitividad empresarial

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ABSTRACT

Context: In this chapter, interface aesthetics and human-centred design are analysed as pillars of corporate governance. In highly saturated and competitive markets, the visual and functional properties of graphical user interfaces (GUIs) become assets of strategic value for decision-making by senior management. Objective: To substantiate the impact of user experience (UX) on business economics through Michael Porter's generic strategies, the mechanisms of horizontal and vertical differentiation, the taxonomies of technological innovation, perceived value and the calculation of return on investment (ROI). Method: A theoretical-descriptive review was conducted, grounded in microeconomic models of product differentiation, neo-Schumpeterian theories of innovation and financial profitability equations applied to the development of intangible software and hardware assets. Results: The review indicates that a harmonious GUI acts simultaneously by increasing hedonic benefits and by reducing cognitive load, which in turn favours customer perceived value (CPV). In addition, a model is put forward according to which the ROI of UX influences both the reduction of internal operating expenses (OPEX) and external commercial traction, including the capture of premium prices. Conclusions: Investment in interaction design is presented as a cross-cutting strategic imperative that contributes to the financial sustainability of the business. The chapter recommends institutionalising empirical metrics in order to predict technology adoption and to mitigate the extra costs arising from subsequent corrective redesign, with the aim of sustaining competitive advantage.

Keywords: Operating expenses (OPEX); Vertical and horizontal differentiation; Cognitive ergonomics; Differentiation strategy

RESUMEN

Contexto: En este capítulo se analizan la estética interfacial y el diseño centrado en el ser humano como pilares de la gobernanza corporativa. Ante mercados altamente saturados y competitivos, las propiedades visuales y funcionales de las interfaces gráficas de usuario (GUI) se consolidan como activos de valor estratégico para la toma de decisiones en la alta dirección. Objetivo: Justificar el impacto de la experiencia de usuario (UX) en la economía empresarial a través de las estrategias genéricas de Michael Porter, los mecanismos de diferenciación horizontal y vertical, las taxonomías de innovación tecnológica, el valor percibido y el cálculo del retorno de la inversión (ROI). Método: Se desarrolló una revisión teórico-descriptiva fundamentada en modelos microeconómicos de diferenciación de producto, teorías neoschumpeterianas de innovación y ecuaciones financieras de rentabilidad aplicadas al desarrollo de activos intangibles de software y hardware. Resultados: La revisión indica que una GUI armónica actúa simultáneamente elevando los beneficios hedónicos y reduciendo la carga cognitiva, lo que favorece el valor percibido por el cliente (CPV). Asimismo, se plantea un modelo según el cual el ROI en UX incide tanto en la reducción de los costes operativos internos (OPEX) como en la tracción comercial y la captura de precios premium externos. Conclusiones: La inversión en diseño interactivo se presenta como un imperativo estratégico transversal que contribuye a la sostenibilidad financiera del negocio. Se recomienda institucionalizar métricas empíricas para predecir la adopción tecnológica y mitigar los sobrecostes por rediseño correctivo posterior, con el fin de sostener la ventaja competitiva.

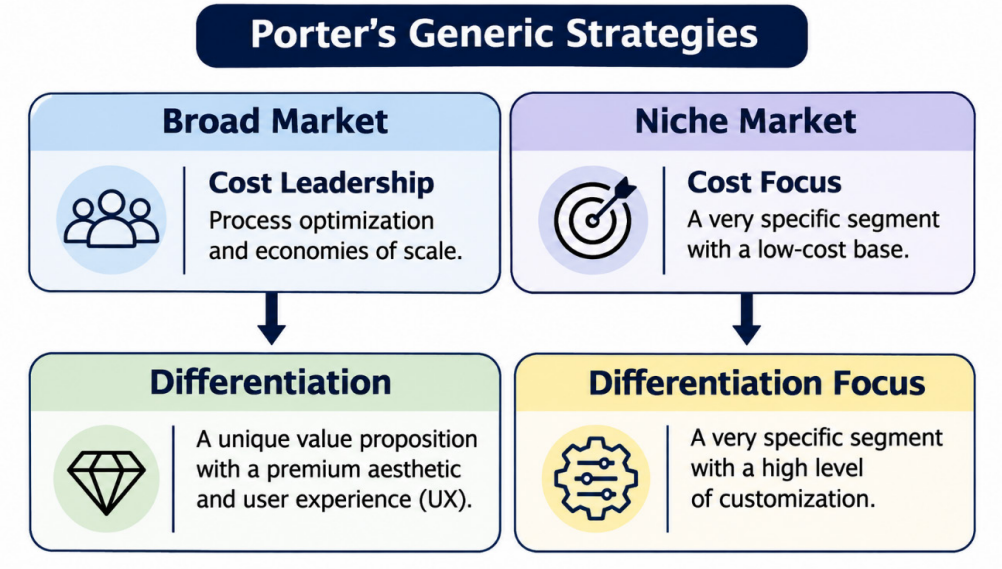
Palabras clave: Costes operativos (OPEX); Diferenciación vertical y horizontal; Ergonomía cognitiva; Estrategia de diferenciación

7.1. MICHAEL PORTER'S COMPETITIVE ADVANTAGE AND GENERIC STRATEGIES

For hardware and software to cease to be interpreted as an isolated technical-operational variable, in which the digital connection between usability design/architecture and the product's aesthetic designs matters only locally, it must be shown that this synergy has a powerful impact on the corporate economy.

The theory of competitive advantage developed by the economist Michael Porter (1980; 1985) is indeed particularly well suited as a theoretical justification within this analytical framework, which examines how the visual standard and the information architecture embodied in graphical user interfaces (GUIs) can determine an organization's strategic position, its long-term economic viability, and its capacity to respond to competition driven by global market forces.

As Porter (1985) emphatically states: "Competitive advantage grows fundamentally out of value a firm is able to create for its buyers that exceeds the firm's cost of creating it." The only way organizations can achieve this superior and sustainable long-term position is to choose a decisive direction and avoid strategic ambiguities such as becoming stuck in the middle. That is, they must rigorously select one of Porter's three generic strategies: cost leadership, differentiation, or focus (Porter, 1980).



The differentiation strategy directs the organization's resources toward developing products or services that target customers unanimously perceive as unique, exclusive and far more valuable. This singular value allows firms to insulate themselves from direct price-based competition, keep their customers satisfied and charge a price premium that amply covers their investments in research and development.

The formal features of the user interface have become one of the most powerful vectors for differentiating a small digital company today, and also nearly one of the hardest to replicate because of scale. If a company produces an interactive software solution or designs hardware using principles of symmetry, geometric balance and formal cleanliness (Garrett's surface plane), it immediately influences consumers at their most visceral level.

This instantaneous positive affective response produces the Aesthetic-Usability Effect: a cognitive bias whereby the customer generalizes external attractiveness to the inherent technical quality and internal usability of the system. This makes sense, because interface design acts as a market signal that helps mitigate information asymmetry and instantly increases the perceived value of your product; it now protects you from being drawn into price competition in technology.

Although aesthetic design falls largely under the differentiation strategy, it works symbiotically with functional usability (Human-Centered Design), which even plays a decisive role in cost leadership strategies. Cost leadership does not mean merely compromising the material quality of a product, but rather radically optimizing internal processes, reducing operational redundancies, and increasing individual productivity through effective use of human capital.

Enterprise corporate software (ERP, CRM system, etc.) with a universal aesthetic applied with restraint through Gestalt principles (proximity, similarity, and common region) greatly reduces command errors: it saves time in logical workflows, executes processes, and reduces technostress

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during office downtime.

This cognitive ergonomics "barrier" generates a high ROI from the perspective of operating expenses (OPEX):

· Reduction in error-related costs: it prevents financial losses associated with incorrect data entry or logic rework.

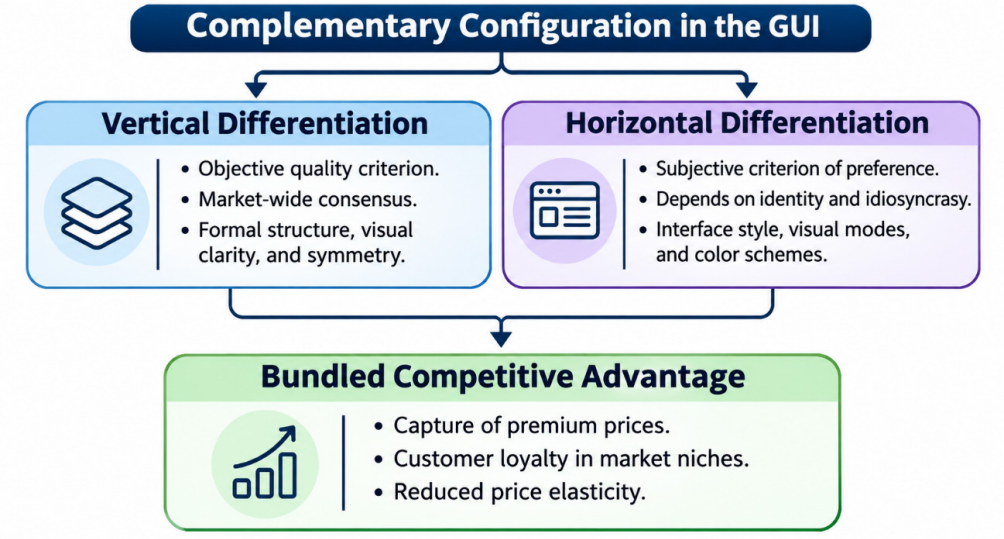
·Reduction in technical support costs: when cognitive tolerance mechanisms for minor errors are induced through aesthetic comfort, the flow of incidents to IT departments drops drastically.

·Reduced training program costs: intuitive interfaces dramatically reduce learning time and the cost incurred by the organization in the continuing education of its employees.

Therefore, interface aesthetics and user-centered design in accordance with the ISO 9241-210 standard are no longer mere design embellishments that only enhance visual appeal; rather, they encapsulate typography as a requirement of senior management. They are cross-cutting strategic tools that can maintain the uniqueness of the product offered at the end-user level (i.e., differentiation) while also protecting operating-cost efficiency within an internal organizational structure.

7.2. HORIZONTAL AND VERTICAL DIFFERENTIATION MECHANISMS IN SATURATED MARKETS

Technology management must therefore draw on microeconomic models of product differentiation in saturated markets if it is to truly understand when a visual standard for an interface gives an organization a sustainable competitive advantage. In hypercompetitive environments, where the inherent "as-is" technical capabilities of interactive systems are beginning to consolidate through programming languages and the standardization of logical hardware components, it is in the interface that a rising industry leader will prevail. In practice, organizations structure their commercial offering by describing two econometrically independent dimensions: vertical differentiation and horizontal differentiation (Tirole, 1988).



When two or more alternative products are compared on the same attribute, consumers all agree that one is objectively better than another; this is an example of vertical differentiation. In Human-Computer Interaction (HCI), vertical differentiation is constrained by how rigorously a surface plane adheres to properly articulated functional usability.

A GUI that displays impeccable white space, corporate typefaces with optimal contrast levels and perfectly uniform geometry (applying Gestalt principles) is always rated by the market as a premium product compared with a cluttered, data-laden deliverable.

This unanimous perception triggers the Aesthetic-Usability Effect and acts as a market signal, reducing information asymmetry for the consumer. Customers translate external formal beauty into a kind of confidence in the quality of the back-end engineering, even if they do so involuntarily. In microeconomic terms, vertical differentiation resolves the dilemma of pure price competition by allowing the technology company to command a higher price while extracting a

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larger share of the social surplus.

Tirole (1988) explains that horizontal differentiation arises when, at identical prices and technical specifications, consumers cannot agree on which product is preferable because the purchase does not depend on an objective quality scale. Firms, for their part, offer products whose attributes are tailored to subjective coefficients such as personal preferences, aesthetic values or lifestyle. This relates directly to the reflective level of emotional design proposed by Donald Norman (2004), which involves assessing the extent to which hardware or software reflects one's identity in our social and business context.

In the modern era of loosely focused Markovian markets, organizations use horizontal differentiation systems when developing interfaces with limited aesthetic variation that does not compromise the calibration of the core algorithms. The following are some clear illustrations of this vector:

· Alternative Visual Modes: this kind of interface, which can switch between a "dark mode" and a "light mode", responds to an operator's aesthetic preferences or to certain ergonomic conditions of use.

· Interface Design Styles: the axis running from skeuomorphic to flat design separates users horizontally according to perceived sophistication or nostalgia for interface textures.

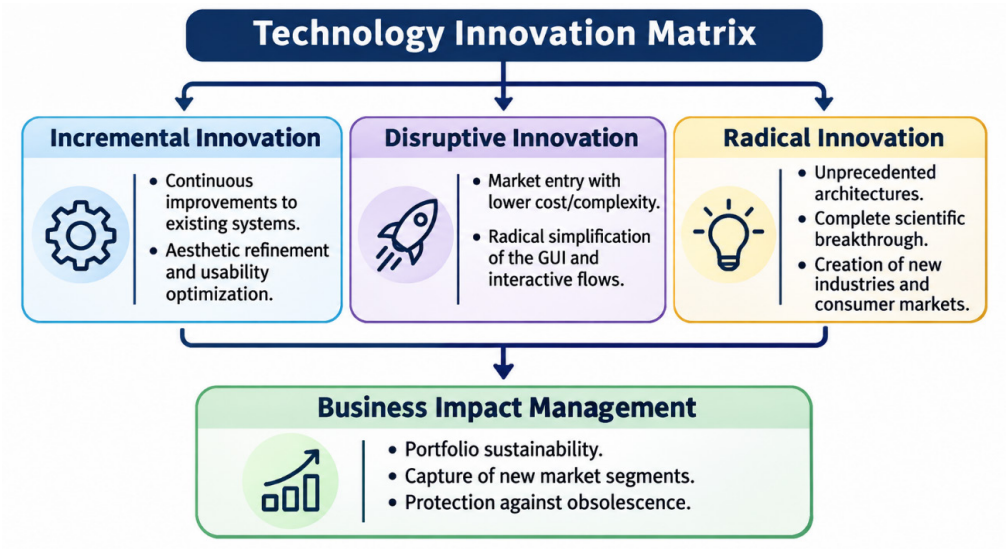
· Theme Customization: giving business operators the ability to change, for example, the color scheme of their organizational control panel (dashboard) increases levels of psychological ownership and the affective sense of belonging to an interactive work tool.

Clearly articulated horizontal (vertically) differentiation strategies allow the organization to avoid massive, undifferentiated competition and to make its way into highly lucrative market niches. By aligning seamlessly with customer subjectivity, the organization builds psychological switching barriers that increase switching costs and reduce the price elasticity of demand, while also shielding the business from competitors' commercial attacks on its market share.

7.3. TECHNOLOGICAL INNOVATION (INCREMENTAL, DISRUPTIVE AND RADICAL)

To successfully integrate interaction design and interface aesthetics into strategic planning, an organization's senior management must link these efforts to the taxonomies of technological innovation (Schumpeter, 1934).

Innovation does not manifest uniformly across hardware and software markets; rather, it can be classified according to its degree of novelty, its influence on organizational capabilities or business processes, and how it shifts market dynamics. These transformations are the focus of the classic innovation management literature, which divides them into three main types: incremental versus disruptive and radical (Christensen, 1997; Freeman and Soete, 1997).



Incremental innovation is characterized by gradual progression, involving relatively minor improvements to already established commercial products, component parts or process technologies (Freeman & Soete 1997). It does not alter the system architecture or create new markets; rather, it fine-tunes existing solutions to optimize their performance, efficiency and

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appeal so that they remain competitive (Henderson & Clark, 1990).

Incremental innovation is the dominant methodology in application design, largely driven by the iterative cycles of human-centered design (ISO 9241-210).

This type of innovation may consist of changing an application's color palette to bring it up to date with design trends, redesigning a menu's typography to improve contrast levels, or reducing the number of clicks required during a software transaction.

Through this layering of subtle aesthetic and functional refinements, the organization improves a user experience that would otherwise be superficial and lightens the cognitive load on the end user. It does so without risking economic stagnation from competitive substitutes, instead preserving the value of defensible differentiation, and without ever having to invest in risky R&D for a truly new technology.

Disruptive innovation is an existing process described by Clayton Christensen (1997) in the bestseller The Innovator's Dilemma. In this process, a product or service that appears strikingly rudimentary, with lower raw performance and much greater cost efficiency than the established solutions offered by the leading companies, typically ends up first at the bottom of a market (or, more simply, among undersupplied features). Over time, the disruptive technology improves progressively until it completely displaces the traditional competitors.

In digital corporate economics, interface design often serves a dual function as a turning point (Norman 2013). Emerging and disruptive organizations usually approach the market by simplifying technological and engineering complexity, the same complexity that saturates the interfaces of dominant companies. By somehow drastically simplifying the structure and surface described by Garrett (2011), these organizations create tools whose inherent usability minimizes the behavioral and visceral levels. This essentially means that these products can be used as they are by uninformed and non-expert consumer segments.

Simplified mobile video-editing applications, which began to appear as an alternative to complex professional post-production software, were one example of this phenomenon in action. They redefined the landscape for tens of millions of new users and shifted the boundaries between the domains of digital design and communication by simplifying work through a GUI that takes over the screen.

Radical innovation refers to a profound and discontinuous break with current knowledge and technologies, as well as with markets (Freeman & Soete 1997). Most of the time, it originates in science-based R&D projects that come to fruition, create entirely new industries and, in turn, decimate many capabilities that existing organizations had mastered under a previous technological paradigm (Henderson & Clark, 1990).

A radical innovation occurs (as when we moved from text-based command-line interfaces [CLI] to a mouse- and window-based graphical user interface that emerged at the Xerox PARC laboratories and later at Apple), and it is not only the source code or the storage hardware that changes; a new mental model / architecture of the copyright system also emerges for human beings.

All three levels of emotional design proposed by Norman (2004) must be fully implemented for radical innovation to occur:

- Visceral: It requires the creation of an entirely new aesthetic language that elicits desire and minimizes instinctive resistance to the unknown.
- At the behavioral level: it drives the invention of new ways of transferring interaction (gesture/pinch on the touchscreen to zoom) that ensure immediate, high operational efficiency.
- At the reflective level: it proposes and changes form, culturally re-signifies, and restructures consumers' subjectivity with a new, adjustable self-concept to strengthen brand value amid the fiercest global competition.

By wisely allocating their investments among incremental, disruptive and radical innovations within a balanced corporate portfolio, technology companies can not only keep the lights on in day-to-day business but also capture near-future markets and, most importantly, anticipate the paradigm shifts that determine whether an organization survives across many periods.

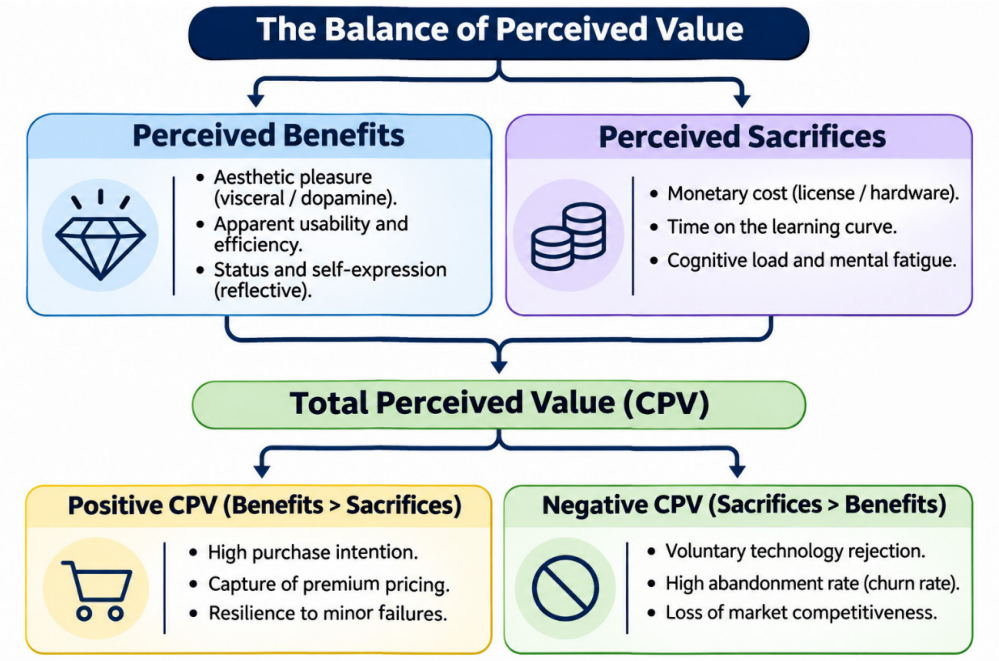
7.4. CUSTOMER PERCEIVED VALUE AS A MEDIATING VARIABLE

To elevate how interface design and investments in the aesthetic standard of hardware (and software) are conceived, moving them from a supporting component to one that drives executive-level decisions, it is important to map these correspondences between display properties and their economic impacts on an organization.

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In this regard, the scientific literature on business strategy and services marketing shows that Customer Perceived Value (CPV) is the predominant psychophysical mediating variable between the functional architecture of an interactive system and business outcomes such as brand loyalty, user retention and positive purchase intention (Zeithaml 1988).

Customer-perceived value is not governed by engineering constants or by a defined objective measure; rather, it is a cognitive and affective evaluation that is relational and subjective in nature. In a consumer's mind, it is operationalized mathematically as a heuristic balance that weighs the total of perceived benefits (including economic, functional, aesthetic, and social value) against the collateral sacrifices associated with its acquisition (monetary cost plus time investment, the cognitive effort involved in learning curves, and the risk of error when operating it).



In this calculation, the formal properties of the UI mediate between the two sides:

· In the benefits dimension: A perfectly formed and balanced surface plane activates an immediate reward mechanism in our brain and elicits visceral-level responses that amplify users' hedonic enjoyment and aesthetic appreciation. Similarly, even a more sophisticated interface reinforces the social benefit dimension and Norman's reflective level.

· Regarding sacrifices: The GUI is designed according to many Gestalt principles and with more complex ergonomic sequences that, taken together, will save a great deal in non-monetary costs, fully integrated systems. The system minimizes cognitive load, reduces work fatigue, and shortens the time needed to complete business tasks by clarifying which information is most relevant. This type of psychological sacrifice associated with depression is what the organization uses to drive the net CPV of the effect.

Formally, perceived value functions as a mediating variable by amplifying the external aesthetic stimuli of the graphical interface and converting them into stable behavioral intentions. It operates by changing how this balance is weighted; specifically, it determines how much Aesthetic play influences concrete instances of judgment relative to Usability, thereby disrupting our intuition about usability through what we see. Evidence from a series of controlled experiments indicates that an attractive GUI immediately leads the user to hypothesize high apparent usability (Kurosu & Kashimura, 1995; Moran, 2024).

This favorable heuristic disposition substantially increases the customer's readiness to accept minor sacrifices. When the software has minor processing delays or logical inconsistencies that are not catastrophically disruptive, a positive dopaminergic impact provides a protective buffer. Consequently, the consumer perceives that the balance still tips in favor of the benefits, which keeps CPV high and offsets any inclination to abandon/not use or switch from competing digital tools.

Interface design helps senior management at software development companies or hardware vendors control perceived value, one of the most profitable pricing strategies. According to Porter (1985), "The ability to charge a premium price depends critically on whether or not differentiation

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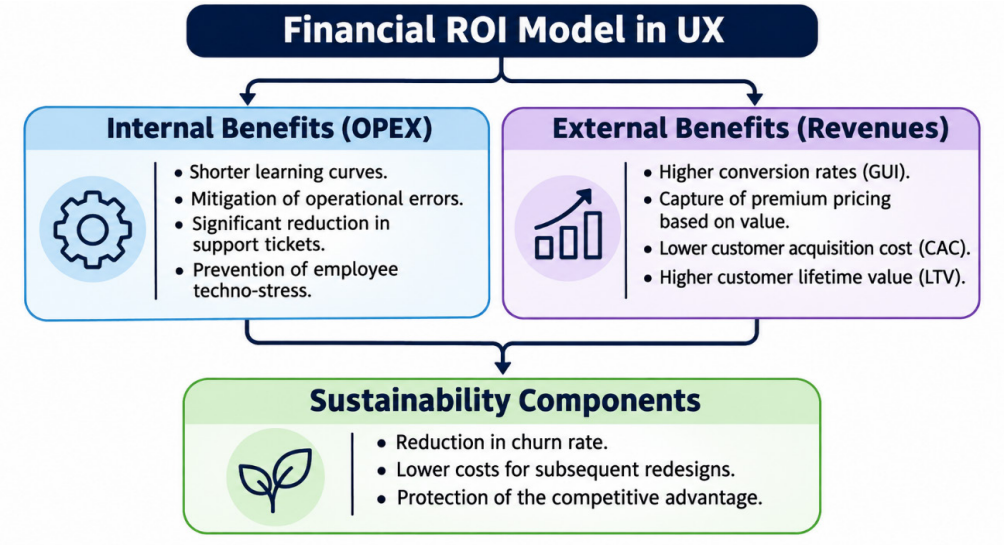
enhances buyer value."

If corporate investment succeeds only insofar as it symbiotically refines technical performance (inherent usability) together with the formal elegance of the interactive environment (apparent usability), a break occurs in the price elasticity of demand.

The customer stops comparing hardware specification sheets or system licensing costs, because the interface has now become established in their mind as a single, fully integrated productive solution for achieving maximum work efficiency and creating unique psychological experiences of positive reinforcement. When perceived value is established as the highest point of the strategy, interface aesthetics is no longer a mere decorative expense but an important part of the core of your business's sustainable competitive advantage, and this is imperative in hypersaturated economies that circulate globally every minute.

7.5. RETURN ON INVESTMENT (ROI) IN UX AND BUSINESS SUSTAINABILITY

To anchor the interfacial presence of aesthetics and Human-Centered Design in corporate governance, senior management must transform psychophysical and relational metrics into requirements for financial profitability. ROI in UX is the definitive analytical argument regarding capital expenditure (CAPEX) for interface design and development in relation to information technology management [2]—[6](Marcus 2020; Rosenberg, 2024). In hypercompetitive and saturated markets, where the focus of a product is so muddled that its very purpose cannot afford to be more than an ornamental sunk cost in the conduct of high-level scientific experimentation disguised as good engineering practice: harness nature and demonstrate that investment in the formal elegance of usability can, in fact, act like a few daisies sprouting among your business model's revenue streams.



The literature on economic usability engineering divides the quantification of UX ROI into internal and external benefits. Internal benefits center on monetary savings (i.e., time/budget) or gains in human/organizational productivity tied to processes within the company, whereas external benefits refer to the impacts that determine product performance in consumer markets.

· A. Internal benefits (optimized operating cost – OPEX)

If a corporation uses internal management software (such as an ERP or a CRM) built on rigorous Gestalt guidelines and disciplined symmetry, the non-monetary cost of its operations plummets. The internal impact on revenue (as defined by the classical formulas of usability engineering) is estimated solely from measurements of the following variables:

· Time savings: Clear, clean interfaces with well-defined hierarchies (Garrett's skeleton plane) reduce the number of seconds needed to complete each task. When multiplied by the number of annual transactions and an employee's hourly cost, this reduction translates into capital savings that a company can deploy immediately.

· Shorter learning curve: Reduced cognitive load decreases the number of days of ongoing "shadowing" training, which speeds up onboarding and lets existing operators become productive in less time.

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• Error mitigation and support: An interface that, through visual comfort alone, provides sensations that facilitate tolerance mechanisms leads to a lower volume of incidents escalated to technical support systems, thereby optimizing these systems in the relevant area.

• B. External Benefits (Commercial Traction and Revenue)

In mass-market, user-oriented interactive consumer products, a more favorable conversion balance is achieved through the graphical interface. By providing a perfectly balanced surface pattern, the floor layout gives new users an immediate sense of competence that lets them navigate each conversion funnel intuitively. As for external monetary returns: a decrease in CAC and an increase (in response to retention + repurchase triggered by the beauty of the system, positively modulated through dopaminergic inputs), with a stable LTV boost.

The Immediate Evaluation-Oriented Return (ROTI), or return, is calculated from the familiar ROI equation, adjusted for both social and technical user experience projects;

ROI = (Cost of UX investment Δ Total benefits $[Savings + Revenue] − Cost of investment) x 100

A comprehensive record of metrics and research in the technology business sector has shown that, for every dollar senior management formally invests in Human-Centered Design processes (ISO 9241-210 standards), an organization is likely to generate a return on investment somewhere between $10 and $100, with a net benefit; moreover, this is one of the most consistent rates of return on capital across all classes of goodwill intangibles.

Over time, this continuous flow of protected operational savings and revenue strengthens the sustainability of the business. If the corporation institutionalizes quantitative empirical measurement processes and participatory co-design methodologies (such as task-based testing, eye-tracking, or SUS/UMUX scales), it can become proficient at predicting user behavior with respect to technology adoption.

Scientific rigor eliminates visual improvisation at its root and eradicates the catastrophic financial cost overruns associated with corrective code reengineering in post-production stages. As a result, hardware and software are implemented as robust, ergonomic, high-efficiency tools that protect the organization’s competitive moat in globally hypercompetitive contexts.

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