LexAid

October 22, 2015

Andrew H. Rawicz
School of Engineering Science
Simon Fraser University
V5A 1S6

Re: ENSC440W Functional Specification - Flipp: A Page Turning Device

Dear Dr. Rawicz,

In accordance with the requirements for ENSC305W and ENSC440, enclosed with this letter are Lex-Aid's technical specifications for Flipp: A Page Turning Device. The goal of this project is to design a device capable of turning the pages of a book in order to facilitate the process of flipping pages for the physically challenged.

This document contains detailed explanation detailed explanation of the all the technical functionalities we intend to implement in our device throughout the various stages of development. We take care to distinguish within these specifications what requirements apply to the proof of concept design and which are applicable to the final commercialized product. Within our specification, we give prioritization to the sustainability and safety of the device. We recognize these factors are of particular importance and thus give them additional consideration.

The Lex-Aid team is comprised of 4 fourth year engineering students: Daniel Miess, Rajdeep Singh, Kamal Ezz and Hesam Bagheri Azghadi. If you have any questions or concerns about the contents of this technical specification please do not hesitate to contact us by e-mail at dmiess@sfu.ca or by phone at (778) 877-2826.

Sincerely,

D Miess

Daniel Miess

Chief Executive Officer

Lex-Aid

Functional Specifications for

Flipp: A Page Turning Device

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Executive Summary

The goal of Lex-Aid is to bring the power of the written word back to those for whom disability has taken it away. The team intends to do so with their revolutionary device Flipp. By making turning the pages of a book as simple as a voice command or a press of a button, the manual dexterity required to turn the pages of a book is drastically reduced.

Due to the time and resource constraints introduced by the nature of the course as well as the nature of the funding we have received, over the next two months we will only be constructing a proof-of-concept version of Flipp. Once the proof-of-concept version is developed, it will be used to prove that the technical challenges that we seek to overcome are surmountable and that users of the device will be content with the product we have created. We will then combine the lessons learned and feedback received, together with our knowledge, to construct a manufacturing process that leads to a reliable final product that is commercially viable.

This document describes the functional specifications for the general Flipp device, while detailing specifications for the individual subsystems. In, we will address concerns related to safety and sustainability.

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Glossary

AC - Alternating Current: Electrical current in which the direction of the flow of charge oscillates with a regular interval

CSA - Canadian Standards Association

DC - Direct Current: Electrical current in which the direction of the flow of charge is fixed

FCC - Federal Communications Commission

ISO - International Organization for Standardization

LED - Light Emitting Diode. A lighting device based on a semiconductor diode

NEMA - National Electrical Manufacturers Association

PCB - Printed Circuit Board: A board that supports and electrically connects the components of an electric circuit

UL - Underwriters Laboratories

1. Introduction

The Lex-Aid Flipp is a device for turning the pages of a book, bringing the printed word back to those for whom disability limits their ability to turn the pages of a book. In order to control the turning of pages, the book is to be placed on Flipp's main platform. Afterwards, the user can easily flip through the pages via voice commands or by pressing down buttons located on a control unit. The requirements for the Flipp device are outlined in this functional specification.

The following figure provides statistics collected to show capability levels of the population. The dexterity ability levels shown are listed in the order of increasing ability. Levels 6 and below represent individuals with difficulties interacting with smaller objects with their hands.

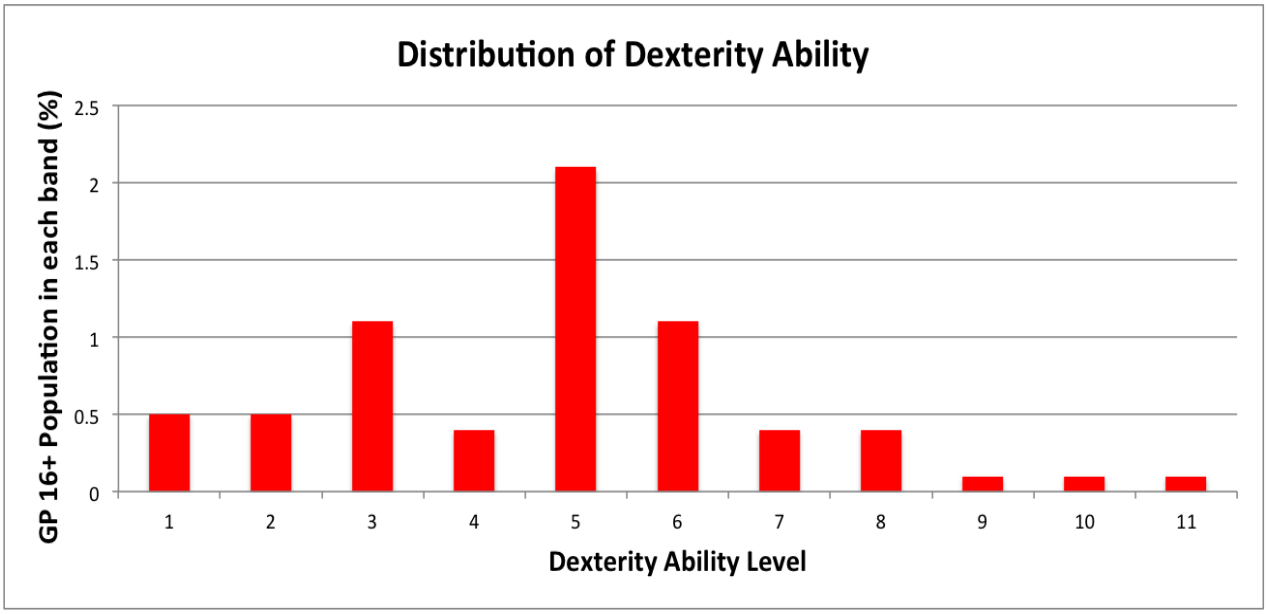

Figure 1: Graph of dexterity level distribution [1]

1.1 Scope

Within this document is a description of the functional specifications that will define the requirements for Flipp. These specifications describe the requirements for the initial proof of concept design as well as for the future commercialize product. In addition, the specifications will also guide the construction of Flipp as we move forward to make this device a reality.

1.2 Intended Audience

The functional specifications document is to be used by all members of the Lex-Aid team, as well as any relevant stakeholders. Throughout the design and implementation of Flipp, this document will be used as a reference to measure the team's progress and the degree of success. This document will also be vital for test engineers, as the criteria for the completed device will be described throughout the specifications. Furthermore, relevant stakeholders will also find this document useful in evaluating the overall success of our final implementation of Flipp.

1.3 Classification

All functional specifications will be labeled using the following convention:

[R a.b.c L]

where a.b.c denote the section of the document in which the requirement appears and L represents the development stage to which the requirement is applied. The different design stages considered are:

I: Required for prototype
II: Required for the final consumer product
III: Required for both the prototype and the final consumer product

2. System Requirements

2.1 System Overview

The Lex-Aid Flipp is a device for automatic turning the pages of a book. It is able to achieve this function through the following procedure. A book is placed open on the main platform and held down by a set of flaps. These flaps are controlled by separate linear actuators and work to hold the book in place, preventing pages from sliding out. The platform is designed in such a way that it can accommodate books of different sizes by sliding the flaps towards and away from the book as needed.

The device has support of a large number of standard book sizes offered by publishers. Efforts have been made to accommodate as many sizes as possible without adding too much extra complexity to the design of the device. Table 1 contains a list of book sizes offered by the publisher Lighting Source and is representative of sizes offered by most publishers.

Table 1: Standard Book Sizes [2]

Book Dimensions in Inches	Book Dimensions in cm	Supported (Y/N)
5 x 7	13 x 18	N
5 x 8	13 x 20	Y
6 x 9	15 x 23	Y
7 x 7	18 x 18	Y
8 x 10	20 x 25	Y
13 x 11	33 x 28	N
13 x 15	33 x 38	N

The device is powered by an external power supply that converts the AC current in the wall to DC that can be used by the device. This power supply is connected to the device through a power jack on the rear of the unit. Once the power connector has been plugged in, the user powers on the device by pressing a switch located on the rear of the device next to the power jack.

The functionality of the device is controlled by a microcontroller system that resides within the main body of the device. This microcontroller triggers the actions of the various motors and actuators required to perform a successful page turning operation. It is also responsible for detecting button presses and auditory input via a microphone located in the front part of the main body of the device. These inputs allow the user to turn the page both forwards and backwards. Figure 1 illustrates how the microcontroller relates to the other subsystems of the device.

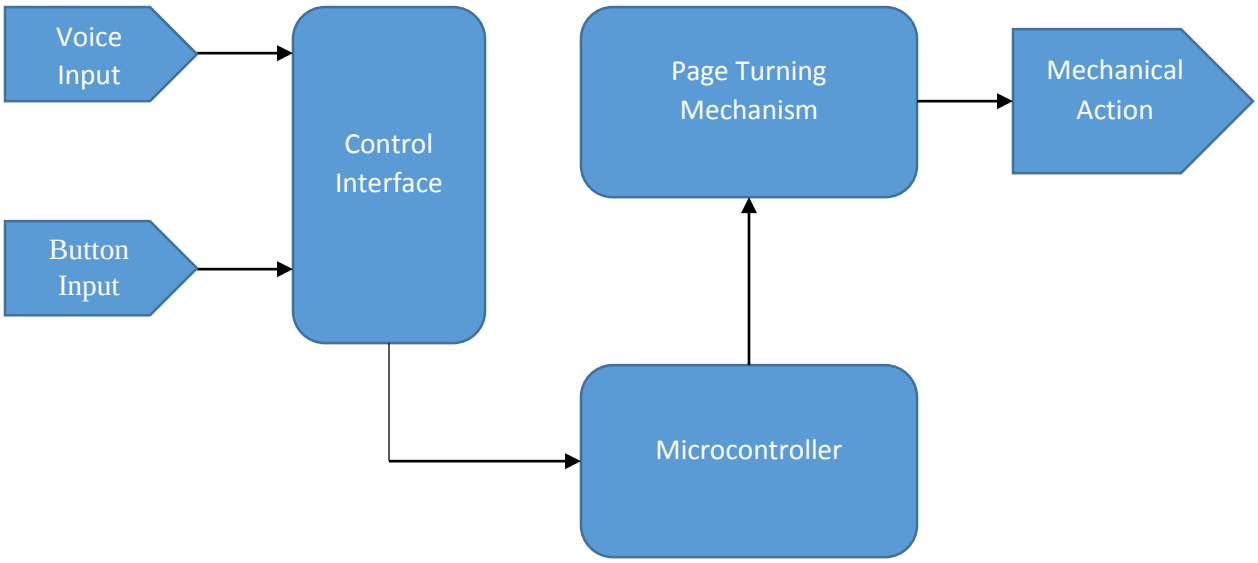

Figure 2: High Level Functional Block Diagram

The main body of the device is composed of metal and its largest feature is a platform for the book to rest on. Rising up from the edges of the platform are a two arms and a number of flaps to support the functionalities of the device. The first of these arms is for lifting a single page up from the book. Using a roller it is able to grip a single page from the top and create a gap between the page and the rest of the book. The second arm hooks onto the raised page using the gap created by the first arm. With a complete rotation, it flips the page over to the other side of the book. In Figure 2, an artistic rendering of the device is shown with the major components labeled.

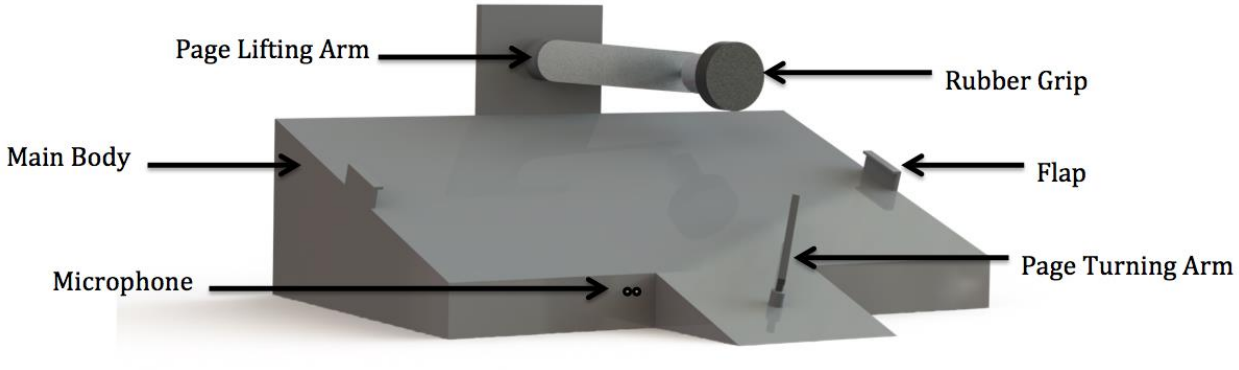

Figure 3: Flipp main body rendering

2.2 General Requirements

[R 2.2.0 - II] – The retail cost of the device will be less than $400

[R 2.2.1 - II] – The device will allow turning of pages manually

[R 2.2.2 - III] – The device will be able to turn pages forwards and backwards

[R 2.2.3 - II] – The device will take a maximum of four seconds to turn a page

[R 2.2.4 - II] – The device will be able to sense a book has been placed on top and engage flaps

2.3 Physical Requirements

[R 2.3.0 - III] – The dimensions for the base of the device will be less than 60 cm by 45 cm

[R 2.3.1 - III] – The maximum height for the device will be 30 cm

[R 2.3.2 - III] – The maximum device mass will not exceed 5 kg

[R 2.3.3 - III] – The device will be capable of turning the pages of a book between the minimum of 15 cm by 20 cm and the maximum 22 cm by 33 cm

[R 2.3.4 - III] – The device will be capable of turning the pages of a book with a page thickness between 50 µm and 250 µm

[R 2.3.5 - III] – The device will minimize obstruction of the user's view of the book

[R 2.3.6 - III] – The controls for the device must be easy to access and buttons will be able to be depressed with less than 5 newtons of force

[R 2.3.7 - III] – The main body of the device will be composed of metal

[R 2.3.8 - III] – The control unit will connect to the main unit via wire with a maximum length of 1 m

2.4 Electrical Requirements

[R 2.4.0 - I] – The device will be powered by a standard NEMA 5-15P wall outlet [3]

[R 2.4.1 - III] – The device will make use of an external 12V power supply that is compliant with UL 60950-1 [4]

[R 2.4.2 - III] – The device will contain a power jack located at rear of the main body

[R 2.4.3 - III] – The device power will be controlled by an on/off switch located on the rear of the main body

[R 2.4.4 - III] – The device will indicate the power on state with a LED located next to the power switch

[R 2.4.5 - III] – The PCB dimensions will not exceed 10 cm by 10 cm

[R 2.4.6 - I] – The PCB will contain accessible debug points throughout the circuit

[R 2.4.7 - III] – The device operation will be controlled by an embedded microcontroller

2.5 Environmental Requirements

[R 2.5.0 - III] – The device will operate within the temperature range of 10°C - 50°C

[R 2.5.1 - II] – The device will tolerate storage within the temperature range of -40°C - 70°C

[R 2.5.2 - II] – The device will operate within the elevation range of 50 m below sea level to 3500 m above sea level

[R 2.5.3 - II] – The noise from the device shall not exceed 60 dB

[R 2.5.4 - III] – The device will operate only in indoor conditions

[R 2.5.5 - II] – The device will operate in the humidity range of 5% to 95%

2.6 Standards

[R 2.6.0 - II] – The device will be in compliance with FCC Title 47 Part 15 Subpart B standards for unintentional radiators [5]

[R 2.6.1 - II] – The device will be in compliance with CAN/CSA-C22.2 NO. 0.12-M1985 standards for wire spacing and bending [6]

[R 2.6.2 - II] – The device will be in compliance with CAN/CSA-C22.2 NO. 0-10 (R2015) standards for wire insulation [7]

[R 2.6.3 - II] – The device manufacturing process will be in compliance IS0 9001 standards for quality management [8]

[R 2.6.4 - II] – The device manufacturing process will be in compliance IS0 14001 standards for environmental management [9]

[R 2.6.5 - II] – The device will be in compliance with WEEE (Directive 2012/19/EU) standards regulating electrical and electronic waste [10]

[R 2.6.6 - II] – The device will be in compliance with RoHS (Directive 2002/95/EC) standards for the reduction of environmental pollutants [11]

2.7 Reliability and Durability

[R 2.7.0 - III] – The device will turn a single page at a time

[R 2.7.1 - II] – The device will have an expected life of 5 years when used within recommended guidelines

[R 2.7.2 - II] – The device will have an expected failure rate of 1 in every 100 page flips

[R 2.7.3 - II] – The device will withstand a drop from a height of 1 m

[R 2.7.4 - II] – The software will be ready to receive input within 20 seconds of power on

2.8 Safety Requirements

[R 2.8.0 - III] – The device will not cause bodily injury to the user when used under normal operating conditions

[R 2.8.1 - III] – Holding the page turning button will not result in multiple page flips

[R 2.8.2 - II] – The mechanical arms will be enclosed to prevent collisions

[R 2.8.3 - III] – The wires are routed and enclosed in a safe manner to prevent loose connections

[R 2.8.4 - III] – All components will be securely attached to rigid structures

[R 2.8.5 - III] – The exposed surfaces of the device will not contain any sharp edges

3. Page Turning Requirements

The main functionality of the device is achieved via the page turning mechanism. This includes all of the mechanical components that are involved in the turning of a page. The two primary components of the page turning mechanism are the page lifting arm and the page turning arm.

The process of turning a page begins with the page lifting arm raising up the page that is to be turned from the surface of the book. The lifting arm is a metal rod that contains a rubber grip. By turning the rod while it sits on the surface of the book, the rubber grip grabs a hold of the topmost page and causes the side closer to the spine of the book to raise up.

Once the page has been raised up on one end, the page turning arm is engaged. The page turning arm is another metal rod. It sits on top of a motor that allows it to spin in a complete circle. It is angled such that as it spins, it will catch the gap that was previously created by the page lifting arm. It will then move the page over to the opposite side of the book where it will be deposited. The page turning arm will then return to its original position, leaving the user's view of the book unobstructed.

3.1 General Requirements

[R 3.1.0 - III] – The page turning system will turn only one page at a time

[R 3.1.1 - III] – The page lifting arm will be able to raise up the page to a minimum of 30 degrees

[R 3.1.2 - III] – The page lifting arm will return to the original position when not in active use

[R 3.1.3 - III] – The page lifting arm will rest on the page surface without additional applied force

[R 3.1.4 - III] – The page turning system will provide identical functionality when turning pages forwards and backwards

[R 3.1.5 - I] – The arm will make one complete 360 degree rotation for each page being turned

[R 3.1.6 - III] – The arm will have sufficient strength to turn a page weighing up to 10 grams

[R 3.1.7 - II] – If the arm is unable to complete a full rotation it will attempt to move back to its starting position by running in reverse.

[R 3.1.8 - III] – Under normal operating conditions the arm will not damage the pages of the book being turned in a noticeable way

3.2 Physical Requirements

[R 3.2.0 - III] – The page lifting arm will consist of a metal rod with a rubber grip

[R 3.2.1 - III] – The page flipping arm will consist of a metal rod capable of rotation

4. User Interface Requirements

The Lex-Aid Flipp can be controlled by the user in one of two ways. The first is by issuing a voice command to the device which is received by a microphone located in the main body. This microphone is connected to a microcontroller which uses a set of third party open source libraries to decode the voice command and turn the page of the book either forwards or backwards. The second method of issuing a command is through a user control unit, which is connected by a wire to the main body of the device. The user control unit consists of two buttons, one of which can be pressed to turn the page forward and the other which turns the page backwards. The user control unit also contains an LED that indicates the power status of the device. The design of the control unit is intentionally kept simple so as to allow other designers to construct additional control units that serve the need of users with particular disabilities. Shown in Figure 3 is an artistic rendering of the control unit.

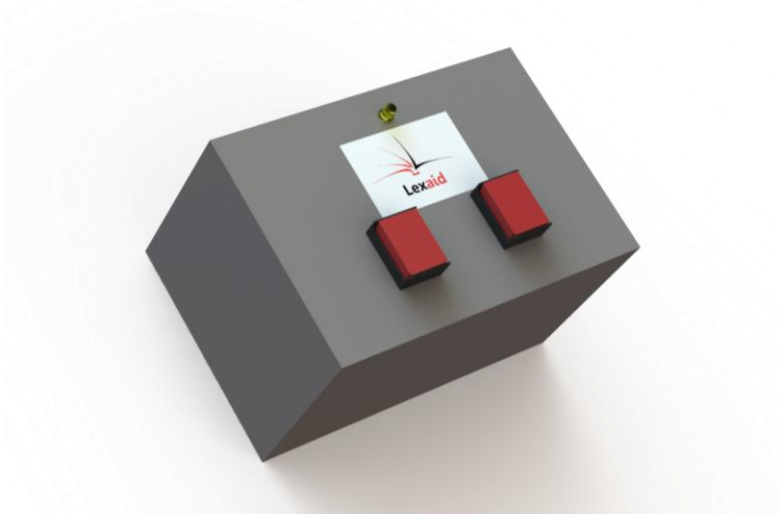

Figure 4: Flipp control unit rendering

4.1 General Requirements

[R 4.1.0 - III] – The user will be able to control the functionality of the device through voice commands or tactile input

[R 4.1.1 - III] – The user control unit will contain a button for forward and a button for backward page turning

[R 4.1.2 - III] – Both user control unit and the main body of the device will contain power status LEDs

[R 4.1.3 - III] – The surface of the microphone will not be obstructed

[R 4.1.4 - III] – The microphone will be sensitive to audio within the range of 80 Hz to 8 kHz

4.2 Physical Requirements

[R 4.2.0 - III] – The buttons will be clearly labelled to indicate page turning direction

[R 4.2.1 - III] – The buttons will have sufficient space between them in order to allow accurate button selection

[R 4.2.2 – III] – Voice recognition will function when the user is within 30 cm of the microphone

[R 4.2.3 – III] – The microphone will mounted within the main body which contains holes to allow for sound transference

5. User Documentation

[R 5.0.0 - II] – The user documentation will be provided in English and explain in clear and easy to understand language how to operate the device. User manual will make use of text, figures, graphs and tables to maximize understanding

[R 5.0.1 - II] – The user documentation will be provided in English, French, Spanish, German, Mandarin, Japanese, Hindi, Punjabi, Arabic, and Persian

[R 5.0.2 - II] – The user documentation will be written for a non-technical audience but will contain appendices with information useful for repair technicians

[R 5.0.3 - II] – The user documentation will contain a troubleshooting and a frequently asked questions section

[R 5.0.4 - II] – The user documentation will be accessible online at the Lex-Aid webpage

6. Sustainability and Safety

At Lex-Aid, we are committed to establishing a reputation for ourselves as both an organization committed to the sustainability of our products as well as to the safety of our customers.

In the construction of our proof-of-concept device, efforts will be made wherever possible to reuse existing components. Only after we have made a reasonable attempt to locate components or materials for reuse will we consider purchasing a new required item. In both the proof-of-concept and the final product, we will be making a concerted effort to use materials that are sustainably sourced and we will be prioritizing the usage of recycled materials. Lex-Aid is also committed to using only materials that are covered under the RoHS standard [y] in an effort to minimize the amount of heavy metals and persistent organic pollutants leached out into the environment.

Safety will always be a prime consideration throughout all stages of the project. In the case that a user is exposed to a moving component, we will always prefer damage to occur to the device over any harm to the user. Care will be taken to ensure that all sharp surfaces of the device have been filed down, eliminating any exposure of sharp edges. All electrical connections will be completely isolated from the user in order to prevent electrocution. In addition, the conversion from AC to DC required for operating the device will occur in an external power unit, which has undergone industry standard safety testing. All exposed metal surfaces will be sufficiently grounded in the case of a wire breaking within the device and coming into contact with the case.

It is our belief that if we give strong consideration to the subjects of sustainability and safety early in our design process, we will easily be able to transition our device to a final commercial product that not only leads in terms of functionality, but also in sustainability and safety.

7. Conclusion

The functional specification in this document lays out both the requirements and the scope for the Lex-Aid Flipp. The specifications laid out will serve as the basis for designing the device and will be referenced once the proof-of-concept has been completed, in order to evaluate the success of the project. During the current phase of development, preliminary work has already begun on the proof-of-concept device and it has an expected completion time within two months. This puts us on track to have our proof of concept completed within the timeframe laid out in our proposal.

References

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[3] ANSI C119.6-2011, American National Standard for Electric Connectors-Non-Sealed, Multiport Connector Systems Rated 600 V or Less for Aluminum and Copper Conductors.

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