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The Social Construction of Time for Mars
Results of Martian Time Survey v1.0 and v2.0-2.2 Compared

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The Martian Time Survey, which can be accessed from the Martian Time website at http://www.martiantime.net collects data over the World Wide Web from respondents regarding their preferences for a timekeeping system for Mars. While more than 40 clock systems and more than 80 calendar systems are known to date to have been invented for Mars since 1880, a seldom considered aspect of timekeeping as an academic study is its social component. There are a great many mathematically valid solutions for a Martian clock and calendar, based on the planet's period of rotation and revolution; however, the subject of timekeeping, including both horology and calendrics, is where the space sciences and the social sciences intersect. Although time is a physical phenomenon, how humans design and use time is a function of culture; time is socially constructed. The Martian Time Survey seeks to develop the often-overlooked social construction of time for the future human habitation of Mars. Although a true social construction requires a functioning society on Mars, the survey represents the first steps on Earth taken on the path to Mars.

Martian Time Survey 1.0, the first comprehensive and sustained effort to collect data on preferences for a human-oriented timekeeping system for Mars, ran from September 1998 to August 2000. After a substantial redesign effort, Version 2.0 debuted in February 2001. This report discusses results through December 2005. The responses recorded in early 2001 were primarily from members of the Martian Time Virtual Conference (MTVC), the online discussion group for Martian timekeeping issues. These initial responses capture a certain level of social construction of Martian time, since the respondents had previously been socialized in the MTVC. Data collected since then, however, comes from recent additions to the MTVC as well as from people having no previous interaction with the group, and are thus non-socialized responses.

In most cases, the data collected in Versions 2.0-2.2 is consistent with the results from Version 1.0. There is a strong consensus on the following aspects of Martian time:

- **A 24-hour clock (8 to 1).**
- **60 minutes per hour and 60 seconds per minute, these units being 2.75 percent longer than their terrestrial counterparts (2 to 1).**
- **A 7-day week (6 to 1).**
- **24 equal-duration months, nominally 28 days each (4 to 1).**
- **A 668-day non-leap year and a 669-day leap year (7 to 1).**
- **A leap-year pattern of odd-numbered years plus decennial years (6 to 1).**
- **A leap day added at the end of the year (7 to 1).**
- **A perpetual calendar with an integral number of weeks per month (2 to 1).**
- **Begin using a Martian calendar now rather than wait for a future event (1.7 to 1).**

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- **Increment the numerical year on the Martian cycle (14 to 1).**
- **Begin the calendar year on the northern hemispheric vernal equinox (4 to 1).**

I. Introduction

VERSION 1.0 utilized a free common gateway interface (CGI) script service. Responses were anonymous, and so there was the possibility that individuals could respond more than once. Version 2.x shifted to email delivery of data. The email address of the respondent was thus collected as part of the data to better ensure that an individual's response was counted only once. It should be noted that in nearly all questions, the Version 2.x data was similar to the Version 1.0 data; thus to a great extent the Version 2.x data validates the integrity of the Version 1.0 data. Any multiple polling in Version 1.0, if it occurred, appears to have had a negligible effect.

The questions in Versions 2.0 and 2.1 are organized according to the hierarchy of time divisions:

- Day (Parts 1 and 2)
- Week (Part 3)
- Month (Part 4)
- Year (Part 5)
- Epoch (Part 6)

Additionally, a number of questions were reworded or restructured, and many questions in Version 2.0 initially had more response options than those available in Version 1.0. Also, Version 2.x is designed to evolve over time, with new response options being added as respondents suggest them. Version 2.1, launched in December 2001, reflected the addition of two new questions.

Integral to the design of Version 2.x is the capability to display concise background information by clicking an "Info" button associated with each response option. Respondents can thus educate themselves on a particular issue and form a more informed opinion before responding. Here, too, respondents are encouraged to provide feedback to improve the quality of background information available to future respondents.

In mid-2003 the survey began upgrading to Version 2.2. No questions were added or deleted; rather, the upgrade consisted of developing multiple language versions. The French version went online in July, and the Spanish version in August. The German and Russian versions came online at the end of 2003. It is hoped that this multilingual capability will result in the collection of more data. Furthermore, the possibility exists that the data will reveal some cultural biases in Martian timekeeping preferences.

Also, the upgrade to Version 2.2 reorganized the questionnaire from six sections to a "Structure" section and a "Nomenclature" section. It is hoped that the more streamlined structure will increase the response rate, since it will require respondents to send only two email messages rather than six. Initial results are encouraging, in that more than half of the 2003 responses came during the last three months of the year, when the restructured questionnaire was online.

Despite the differences between Versions 1.0 and 2.x, there is a very significant degree of correlation in the responses to most of the questions. The correlation of these data sets, gathered by two substantially different means, is mutually validating in most cases.

This report on the results of Versions 1.0 and 2.x covers only structural and not nomenclatural issues of Martian timekeeping. To employ an automotive metaphor, it is necessary to first characterize the public's preferences regarding the design specifications of a vehicle: its size, seating capacity, performance characteristics such as acceleration and fuel efficiency, et cetera. Once these basic design issues are settled, we can decide on the catchy marketing names and the paint job.

Where there is a direct relationship between a question in Version 1.0 and Version 2.x, these are discussed together.

II. The Day

Because the length of the Martian solar day is 2.75% longer than an Earth day, a new clock for Mars must be considered. Questions 1-1 and 1-2 of Version 2.x, "How many primary divisions should there be to the Martian day?" and "For x primary divisions, what pattern of smaller divisions should there be to the Martian day?" Both questions related to Question 1-1 from Version 1.0, "How should the Martian sol be divided?" The original question was broken down into two component questions to reflect the hierarchical division of the Martian solar day. (Note that in Version 2.x the word "day" was used in lieu of "sol," even though this term has become standard. "Sol" is an option in the "Nomenclature" section of the survey, so it would have been confusing and prejudicial to use the term in questions pertaining to structure.) Conditional to the answer provided to Version 2.x Question 1-1, respondents were asked a variation of Question 1-2 specific to the earlier answer, with the appropriate options. As shown in Figure 1-1, in both surveys, 24-hour options were far and away the favorites. In Version 1.0, these accounted for 65.1% of the responses, while in Version 2.x, 62.3% of respondents preferred to divide the Martian day by 24 primary divisions, out-polling its nearest competitor by a ratio of 8 to 1.

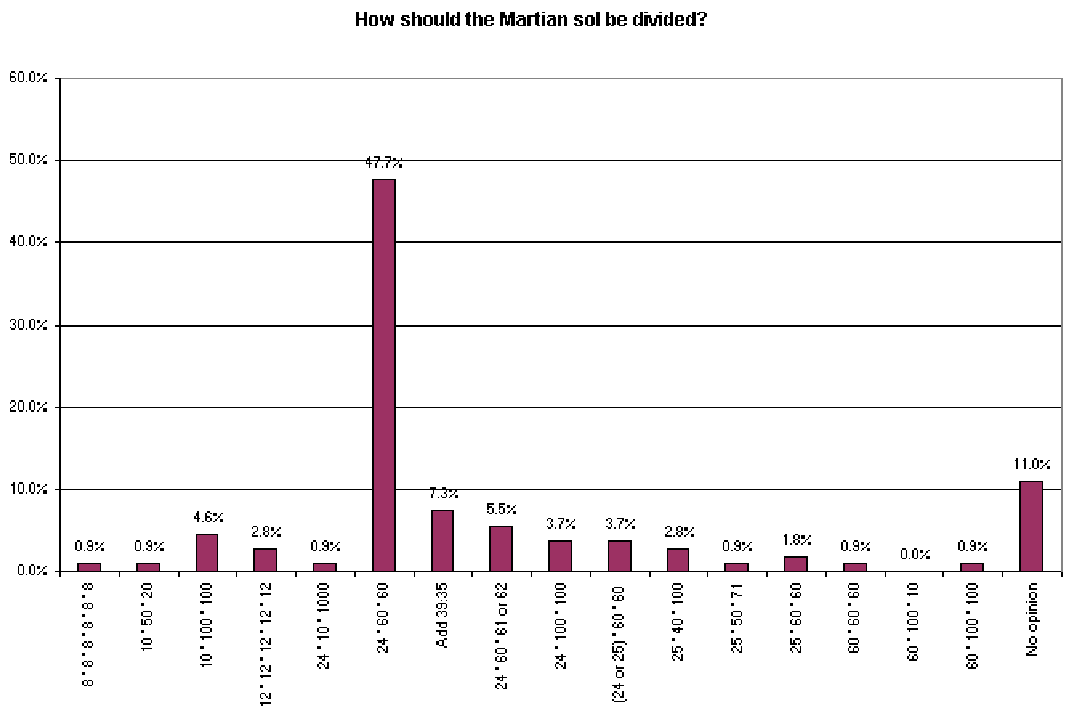

Figure 1-1 v1.

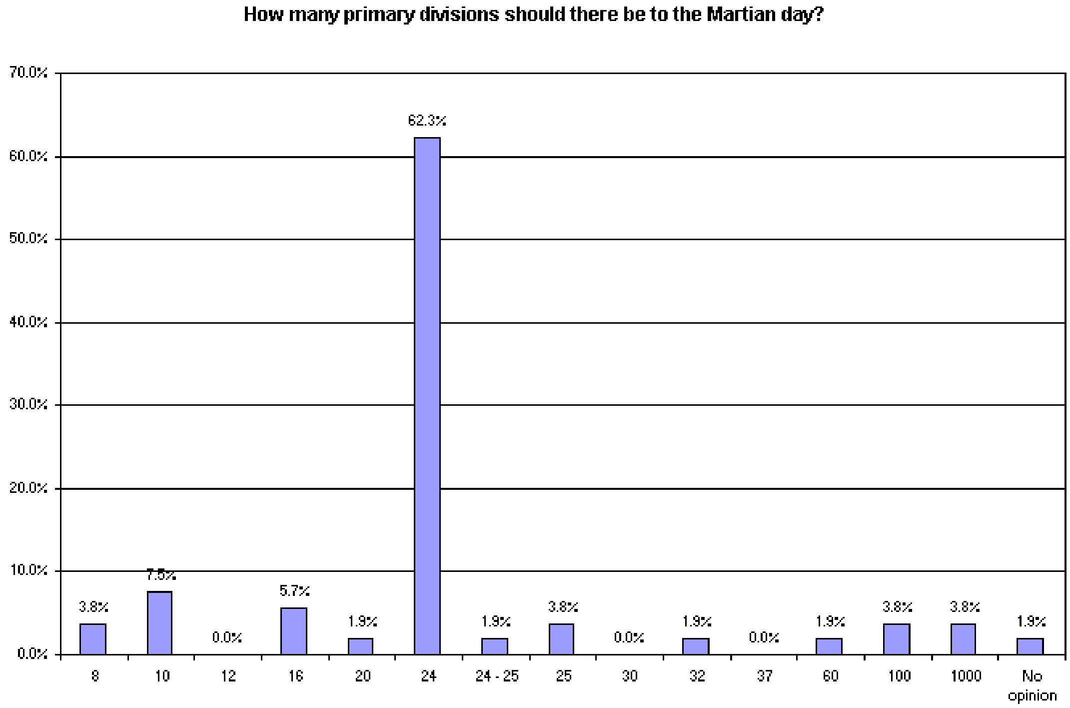

Figure 1-1 v2.

Figure 1-1a shows the history of responses to v2.x Question 1-1 and its v1.0 antecedent.

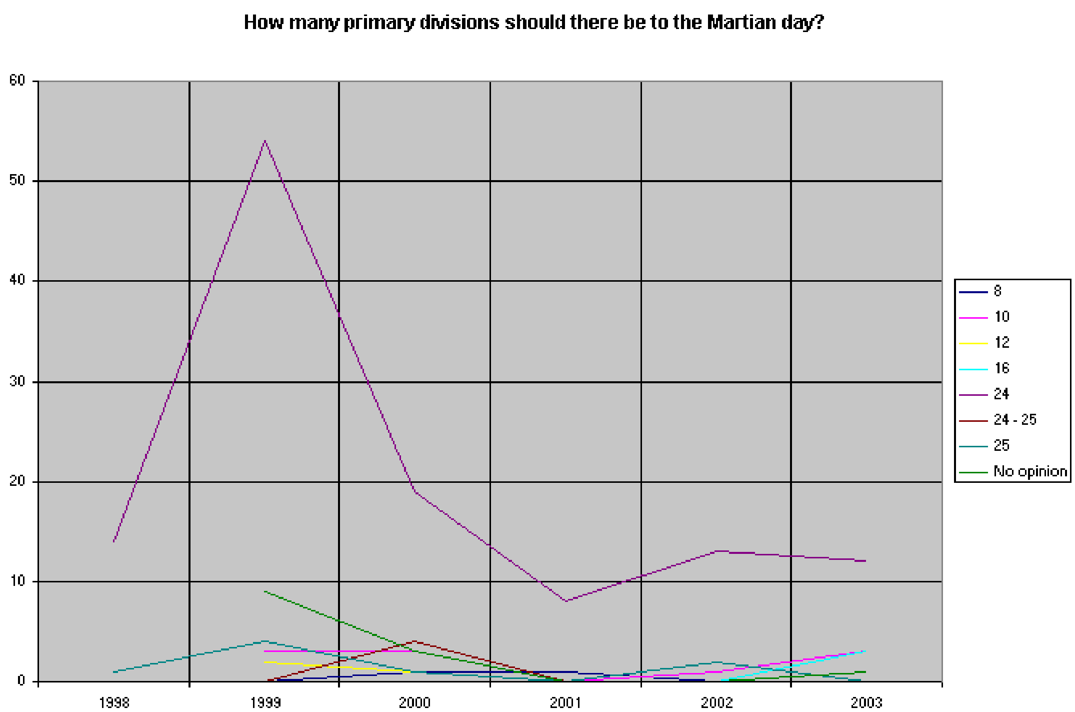

Figure 1-1a.

In Question 1-1 of Version 1.0, selection of the stretched 24:60:60 clock accounted for 73.2% of the total responses to the five 24-hour options. In Question 1-2 of Version 2.x, selection of this option represented 53.1% of 14 (including "No opinion") possible responses (see Figure 1-2). There was a sharp increase in support for the "24:60:60 + 39:35.244" or "time-slip" option popularized in Kim Stanley Robinson's Red Mars, Green Mars, Blue Mars trilogy, rising from 7.3% in Version 1.0 to 28.1% in Version 2.x. Even so, this is barely half the response for the stretched 24:60:60 clock.

It should be noted that the stretched 24-hour clock has been used by astronomers to describe the local time on Mars at least since Percival Lowell in 1894. The first functional Martian clock, developed by the astronomer I. M. Levitt in 1954, used this system. NASA/JPL adopted the stretched 24:60:60 clock for the 1976 Viking lander missions, and it has been used for all subsequent missions on the surface of Mars. This is one of the few generally agreed upon and commonly used aspects of Martian time today, and although not a de jure standard, represents a de facto standard established by custom and use.

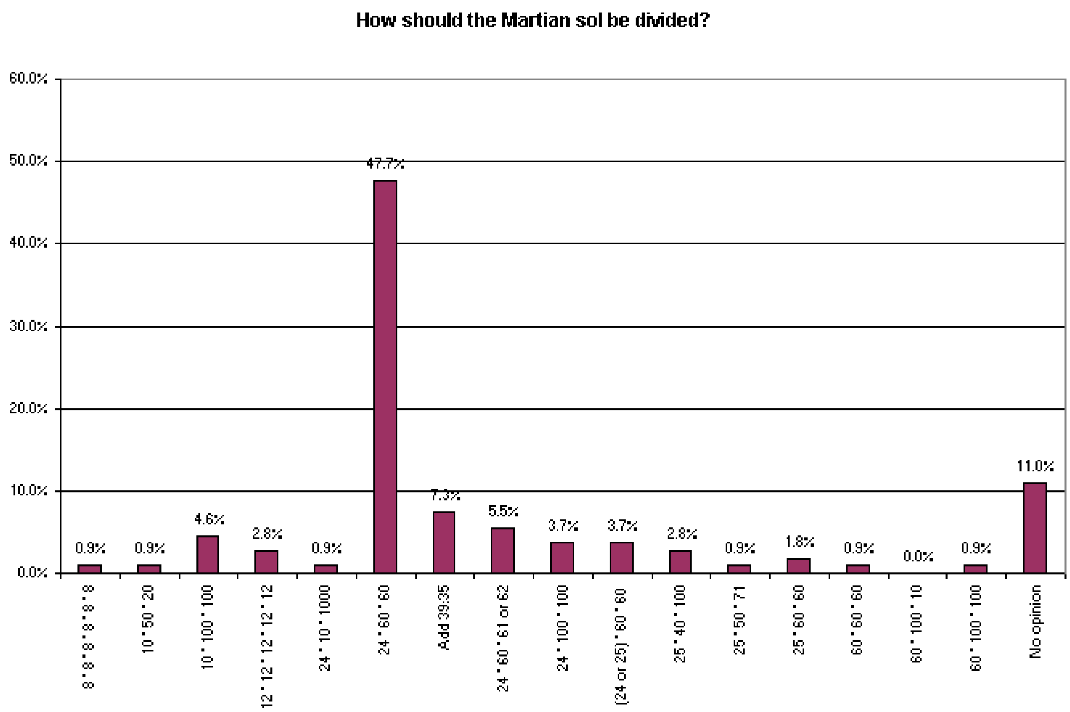

Figure 1-2 v1.

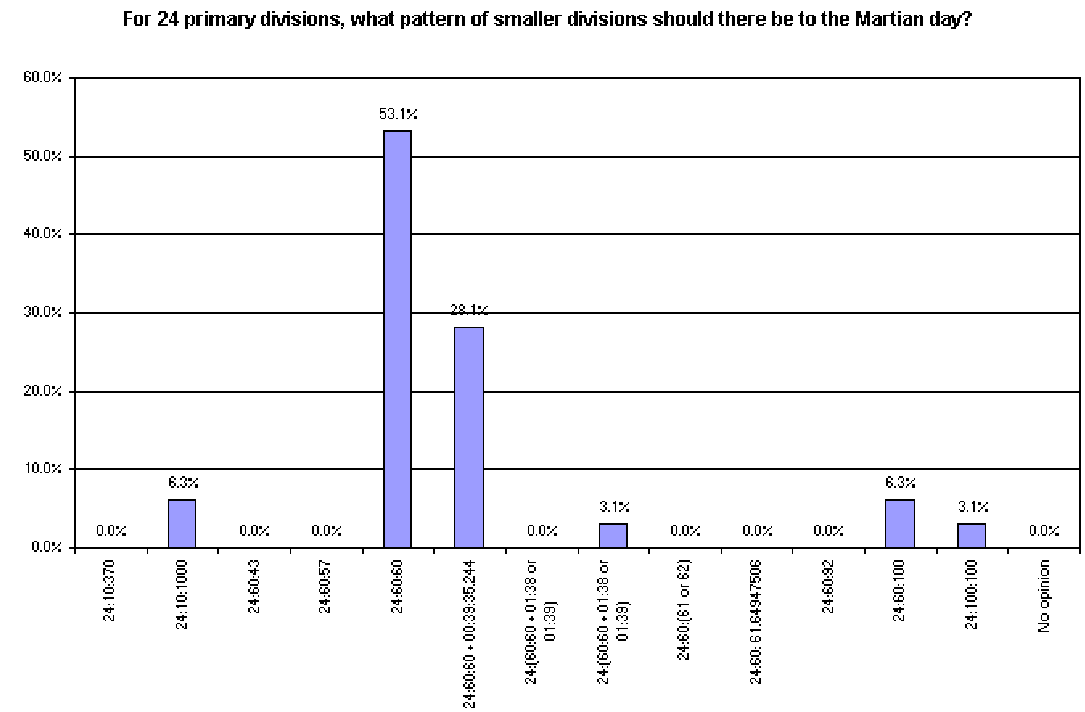

Figure 1-2 v2.

Figure 1-2a shows the history of responses to v2.x Question 1-2 and its v1.0 antecedent.

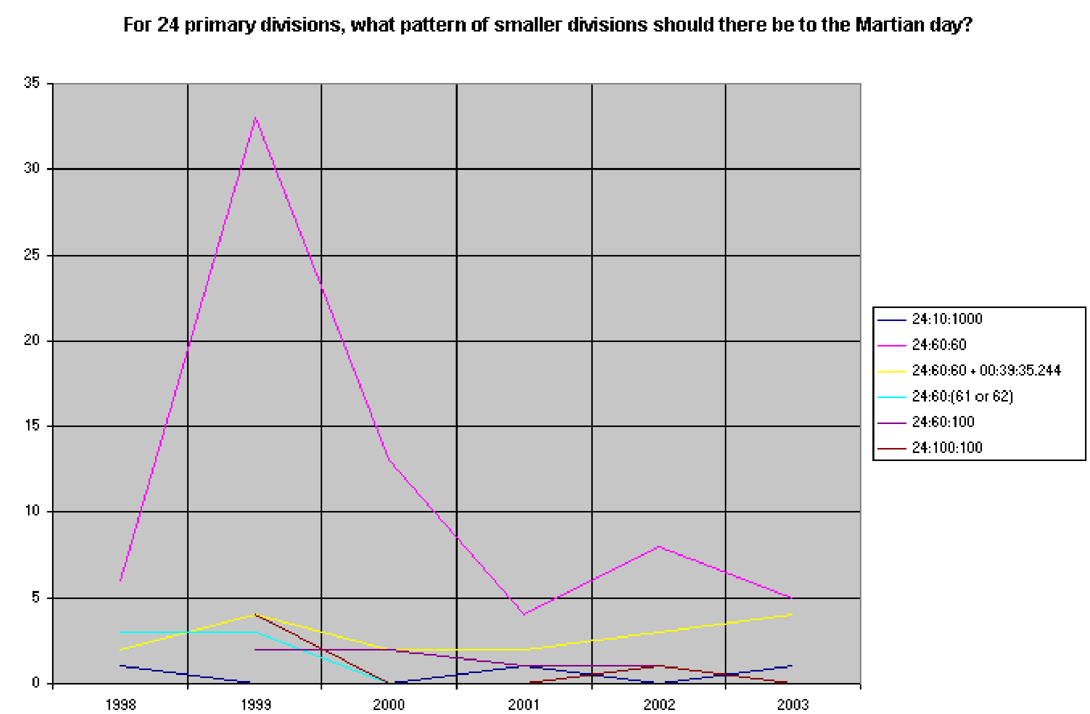

Figure 1-2a.

Section 2 of Versions 2.0/2.1 contained nomenclatural questions regarding the day and its divisions.

III. The Week

Question 1-7 in Version 1.0, "How many sols should there be in a Martian week?" and Question 3-1 in Version 2.x, "How many days should there be in a week?" are functionally equivalent. In Version 2.x, the option of "9 days" was added. The "7 days" option was a runaway favorite in both surveys, polling 68.8% in Version 1.0 and 71.7% in Version 2.x (see Figure 3-1). In Version 2.x, the seven-day week out-polled it nearest competitor by a ratio of 6 to 1.

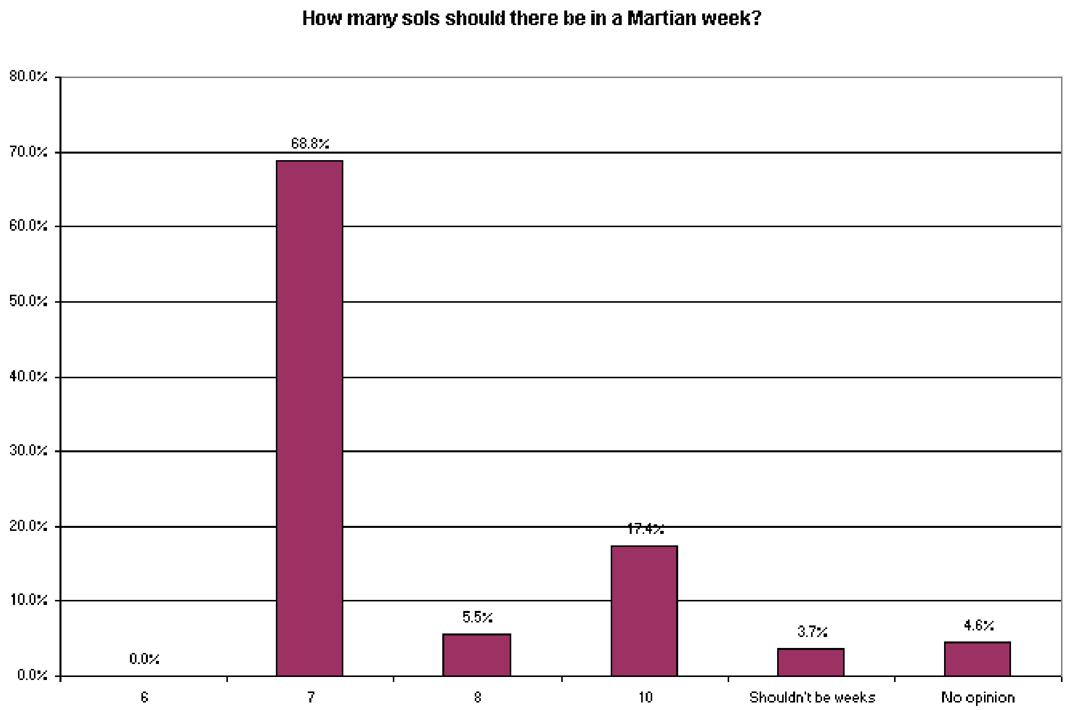

Figure 3-1 v1.

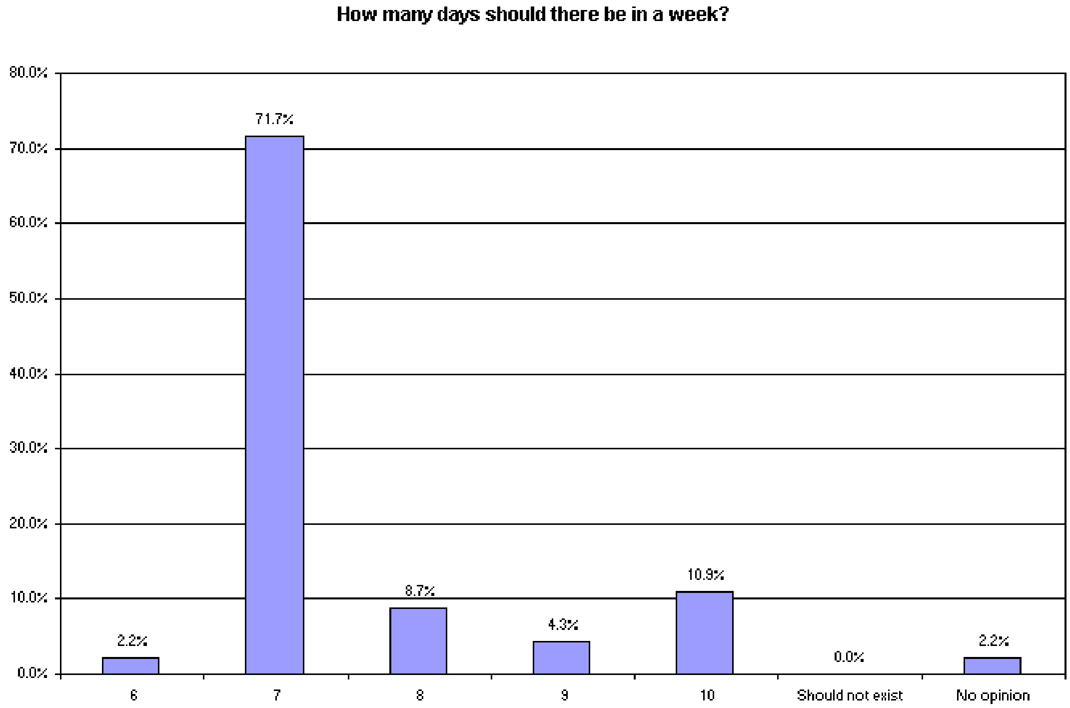

Figure 3-1 v2.

Figure 3-1a shows the history of responses to v2.x Question 3-1 and its v1.0 antecedent.

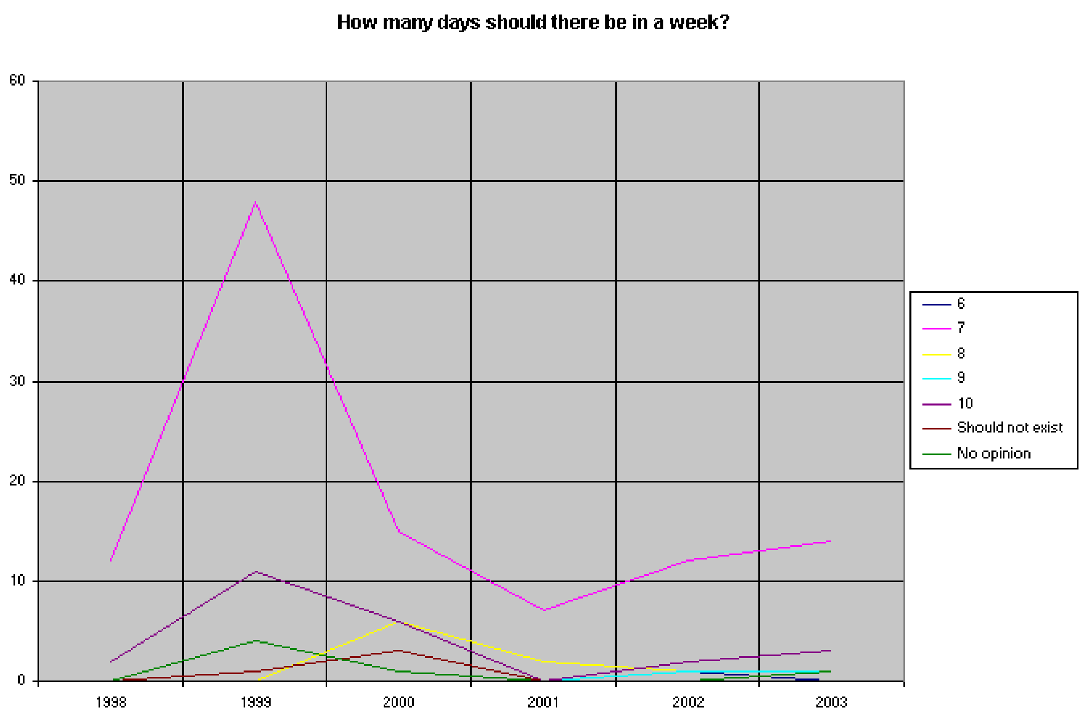

Figure 3-1a.

IV. The Month

Because of the pronounced eccentricity of Mars' orbit around the sun, there are two logical schemes for dividing the year into months, one based on geometry and one based on time. Question 1-5 in Version 1.0 asked, "Should Martian months be of equal duration, or should they span equal arcs in Mars' orbit?" The equal-arc option represented 22.9% of responses, and the equal-duration option accounted for 67.9%, a 3 to 1 ratio. No equivalent question was asked in Version 2.x; however, the four equal-arc options provided in Question 4-1, "How many days should there typically be in a month?" collectively accounted for 15.7% of the responses, while the combined responses for equal-duration months represented 80.0% of the total, a 5 to 1 ratio (see Figure 4-1a). While a discussion of trends should wait for the availability of more data, at this point it appears that opinion is shifting further away from equal-arc months in favor of equal-duration months.

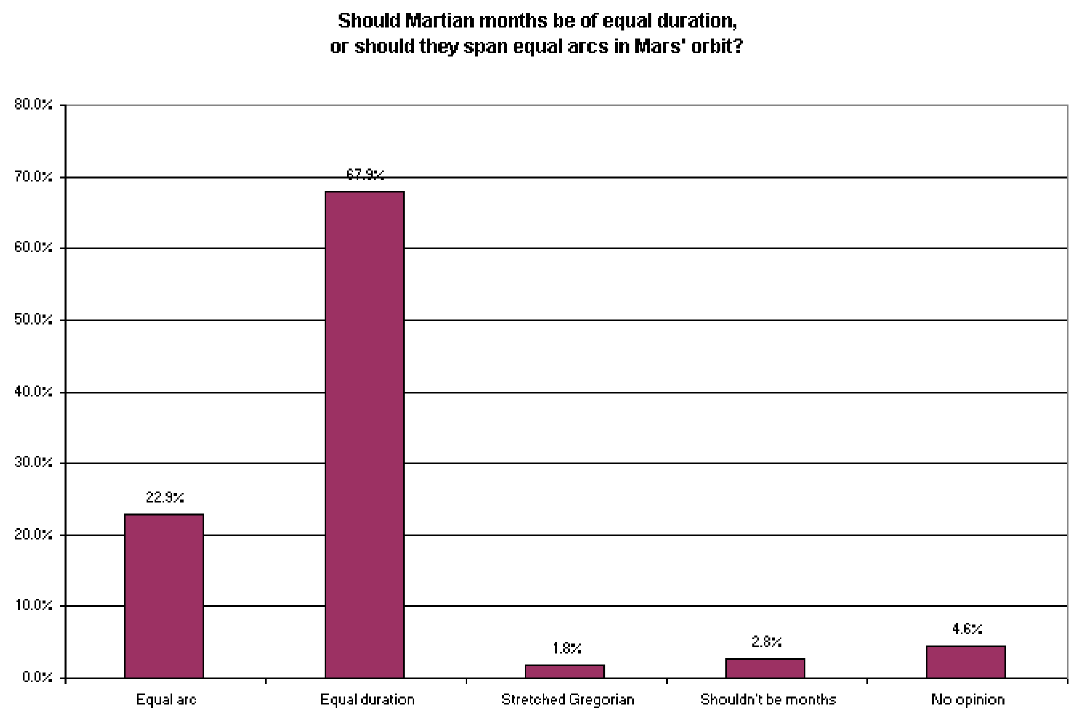

Figure 4-1a v1.

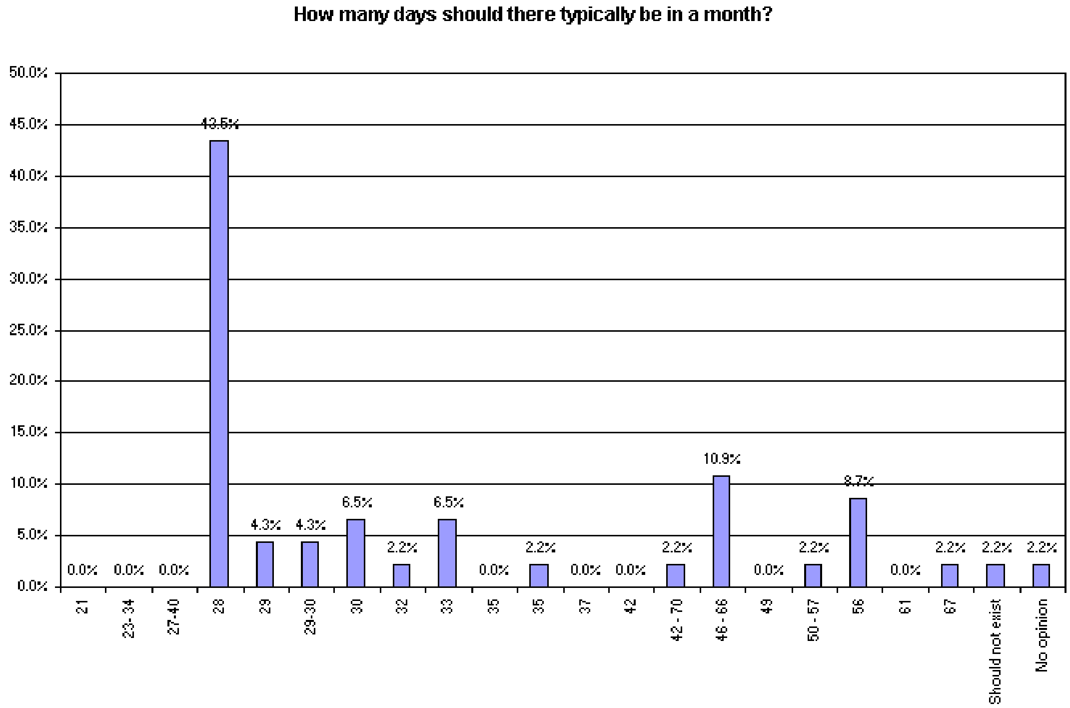

Figure 4-1a v2.

Question 1-6 in Version 1.0, "How many sols should there usually be in a Martian month?" was specific to equal-duration months, whereas Version 2.x Question 4-1 included both equal-arc and equal-duration options. In Version 1.0, the 28-day month (for a total of 24 months per year) accounted for 45.0% of responses, while in Version 2.x, the same option polled 43.5% of all responses (both equal-arc and equal-duration months) and 54.1% of only the equal-duration month options (see Figure 4-1b). In Version 2.x, the 28-day month out-polled the second most popular option by a ratio of 4 to 1. Based on the currently available data, the consensus for the 28-day month continues to be very strong.

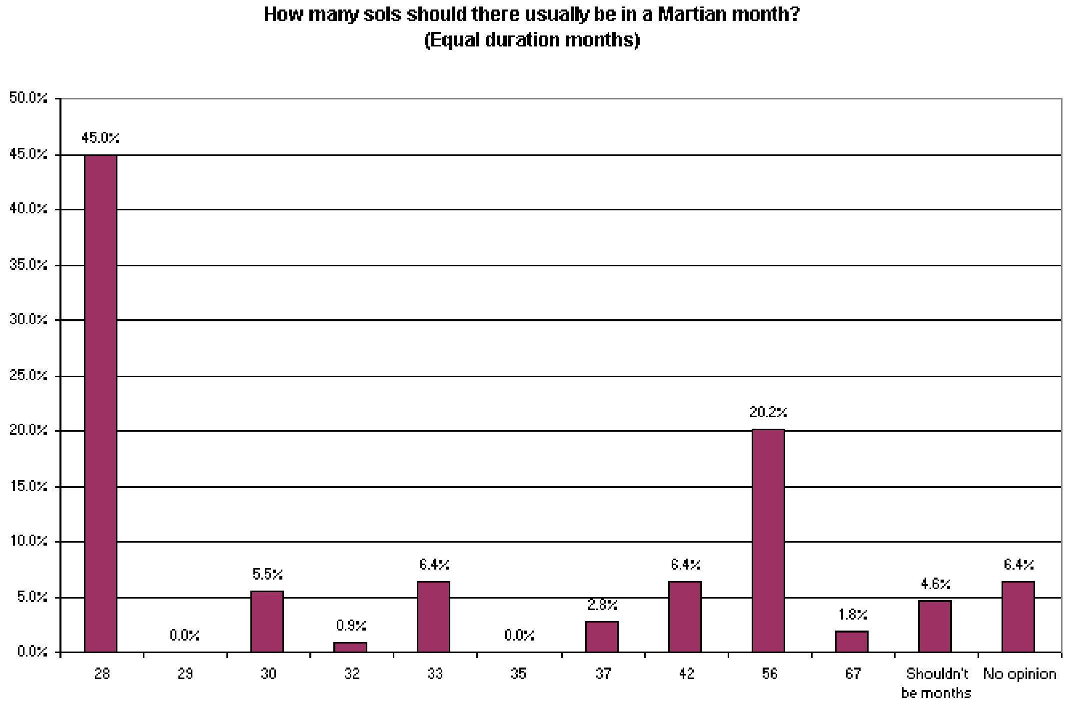

Figure 4-1b v1.

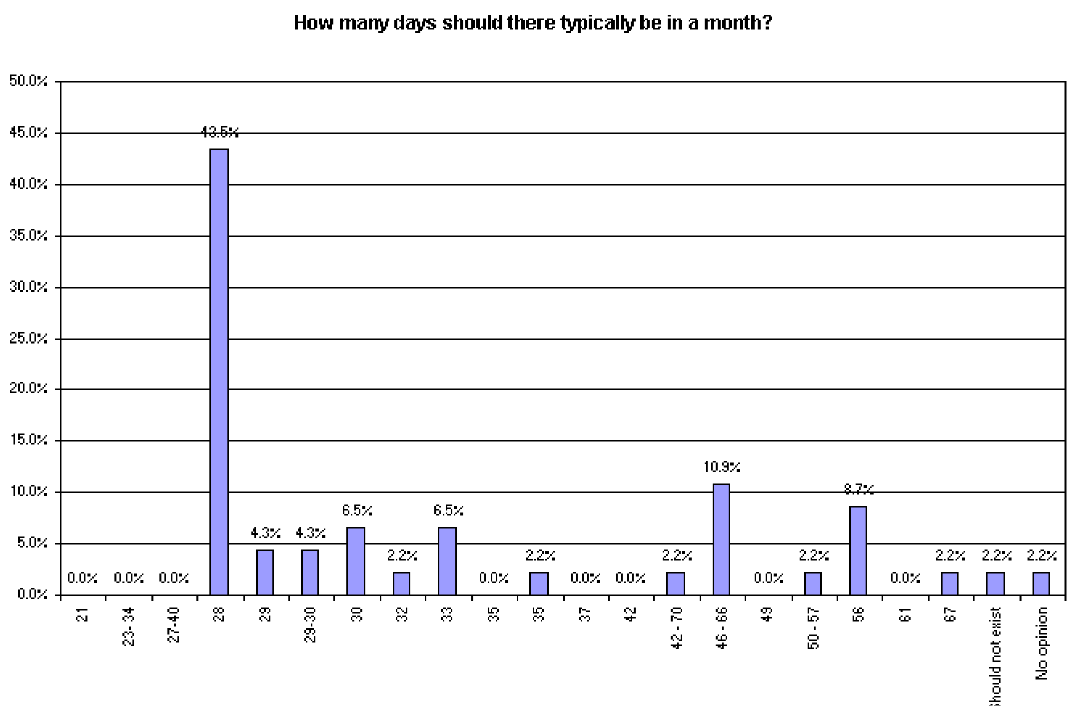

Figure 4-1b v2.

Figure 4-1c shows the history of responses to v2.x Question 4-1 and its v1.0 antecedents.

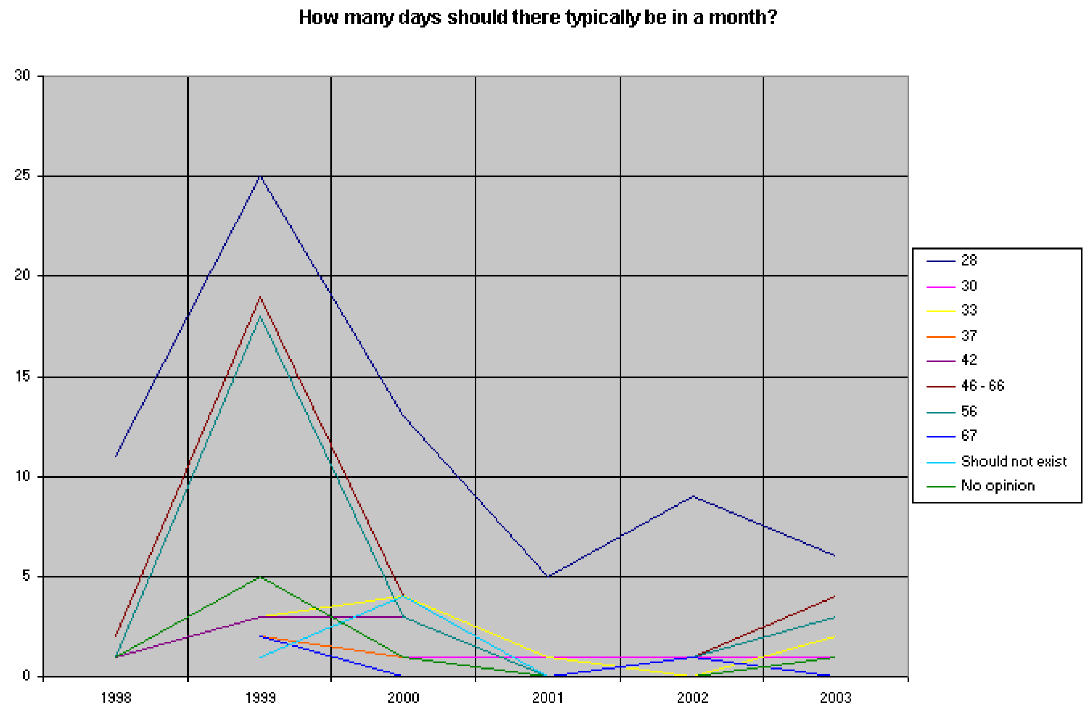

Figure 4-1c.

V. The Year

Question 1-4 from Version 1.0 asked, "Should the Martian calendar have a leap sol or a leap week?" In Version 2.x, Question 5-1 was phrase differently: "How many days should be added in a leap year?" However, the results compare fairly closely. In Version 1.0, the "leap sol" option received 74.3 percent, while in Version 2.x, the "1 day" option accounted for 66.7% of total responses. This slight decrease in the response rate for the "1 day" option is unsurprising given the greater number of options available compared to the related Version 1.0 question (see Figure 5-1a). Preference for the "leap sol" option led other options by 7 to 1. Although support for the "leap week" option in Version 1.0 was weak at 11.0%, it is surprising that the leap week options in Version 2.x ("7 days" and "10 days") garnered only 2.4% combined. Again, while it may be premature to discuss trends, the early indication is that consensus is coalescing around the single leap day, and support for the leap week has evaporated. See the discussion of Figure 5-1b for additional results regarding the leap week concept.

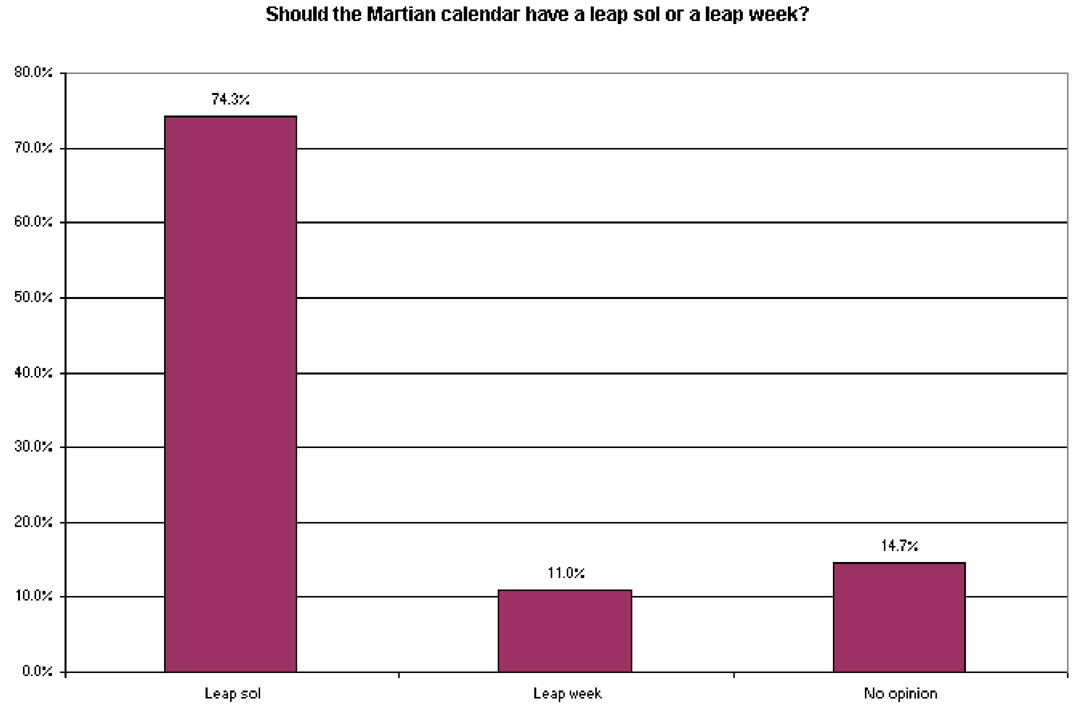

Figure 5-1a v1.

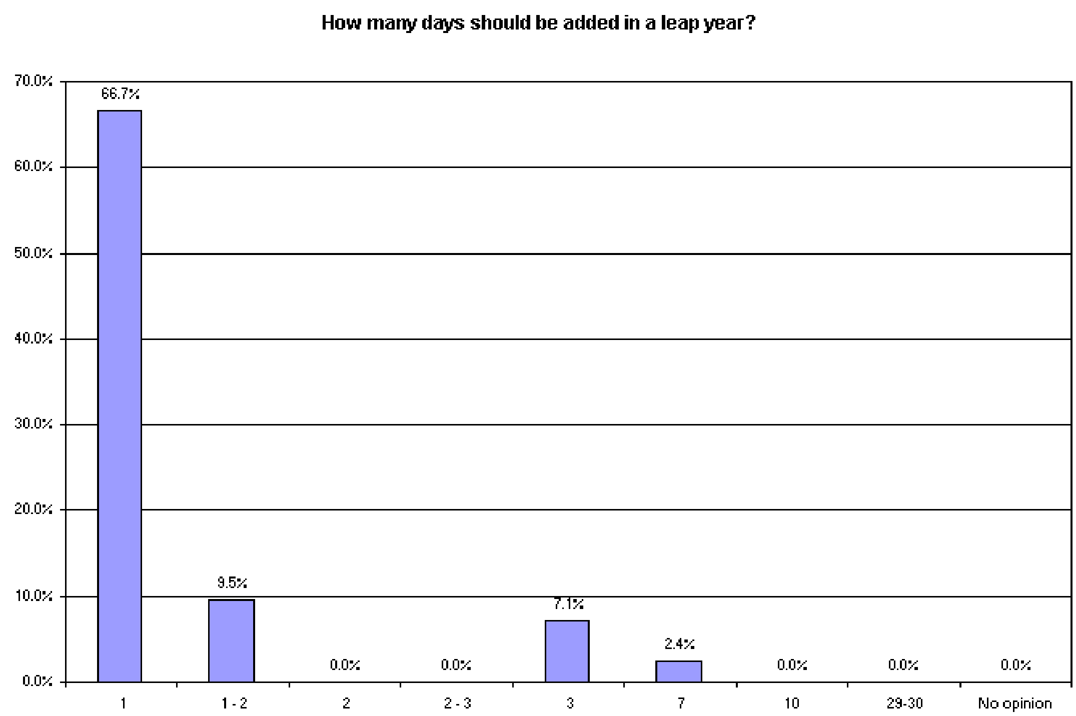

Figure 5-1a v2.

Question 2-3 from Version 1.0 asked, "How should the length of calendar year vary?" In Version 2.x, the related question was again 5-1: "How many days should be added in a leap year?" The results were substantially the same in the two questions. In Version 1.0, the "668, 669" option, the only one representing the addition of a single leap day, polled 76.1%, while in Version 2.x the single leap day option accounted for 66.7% of responses (see Figure 5-1b). The 668-day non-leap year and 669-day leap year was preferred by more than 7 to 1 over any other option.

Although the "leap week" option received 11.0% of the responses in Version 1.0 Question 1-4 (see Figure 5-1a), the "665, 672" option in Question 2-3, the only one representing the addition of seven days, received only 4.5%. In the Version 2.x question, the "7 days" option received only one response, and the "10 days" option received none.

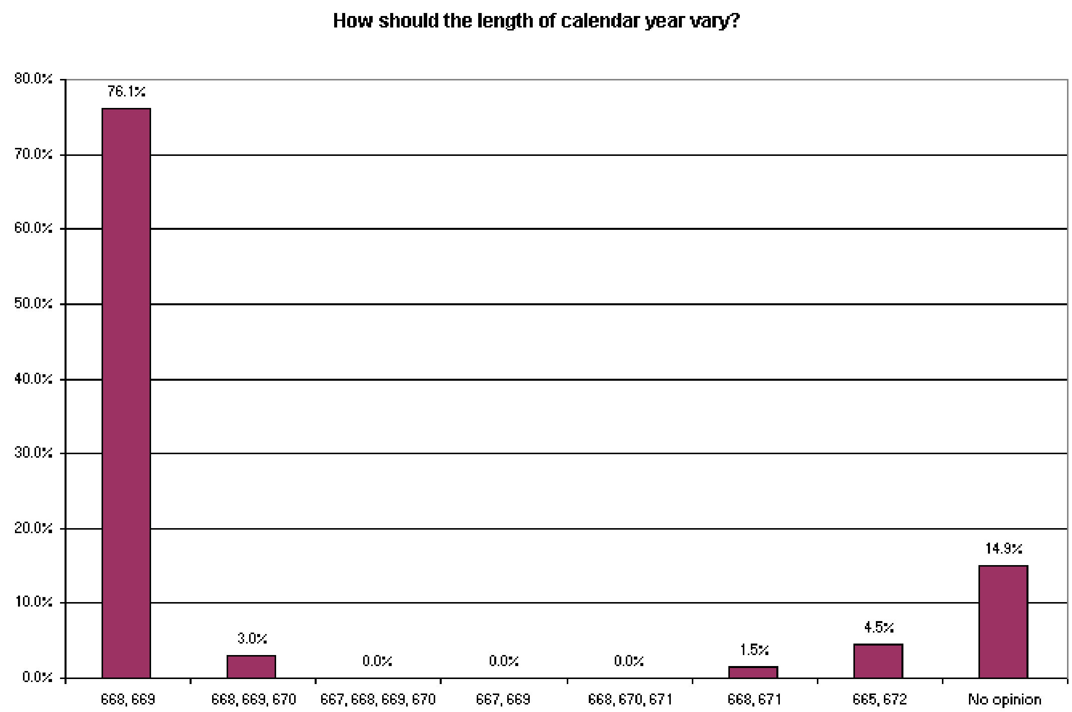

Figure 5-1b v1.

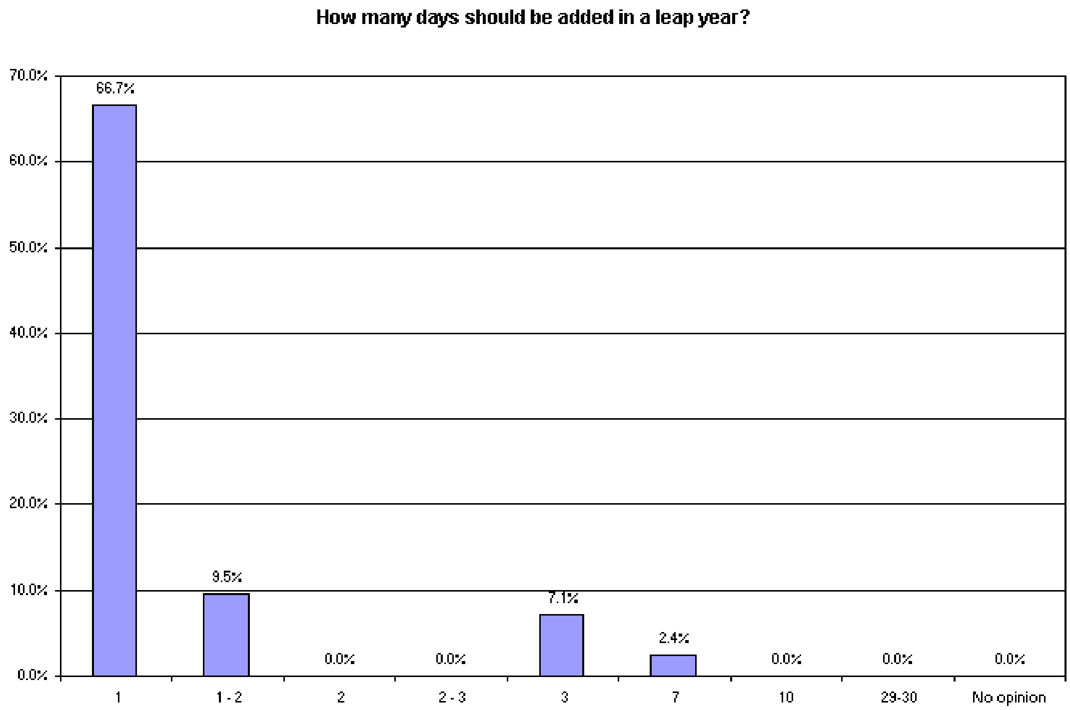

Figure 5-1b v2.

Figure 5-1c shows the history of responses to v2.x Question 5-1 and its v1.0 antecedents.

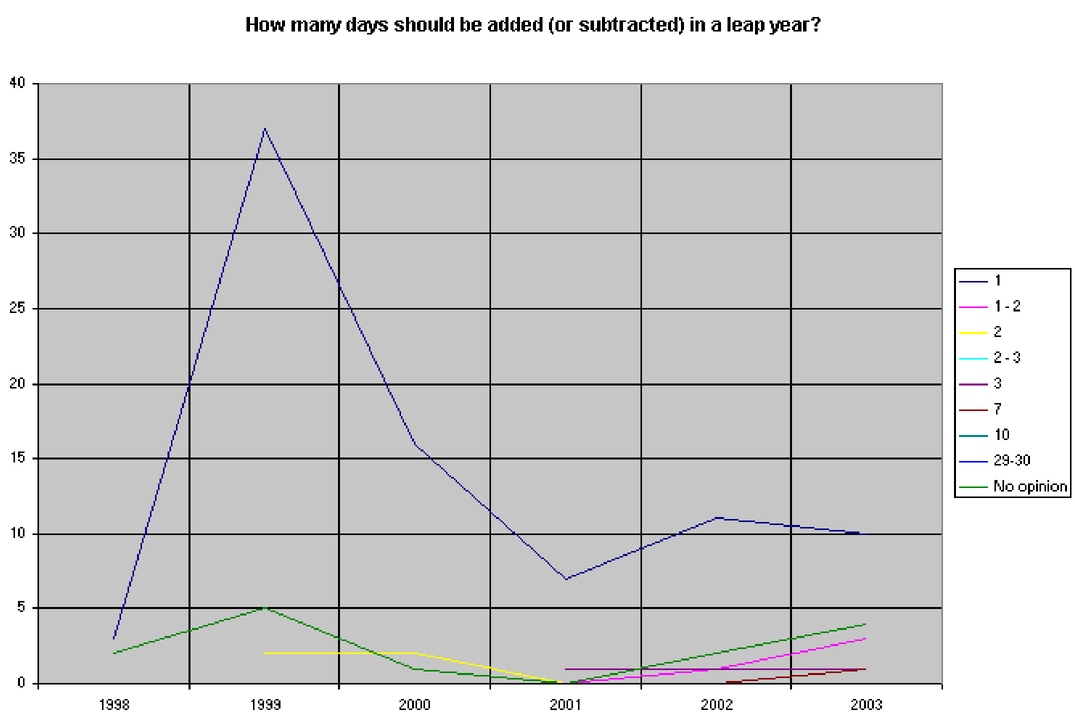

Figure 5-1c.

In Version 1.0, Question 2-2 asked "What would be an acceptable leap year scheme for a Martian calendar?" Conditional to the answer provided to Version 2.x Question 5-1, respondents were asked a variation of Question 5-2 specific to the earlier answer, with the appropriate options: "For x leap days in a year, what should be the basic leap year scheme?" In Version 1.0, the "Odd years plus decennial years" option garnered 50.7% of the total responses, out-polling its nearest competitor by 3 to 1. In Version 2.x, the same option captured 64.3% of the responses. The leap-year scheme of odd-numbered years plus decennial years is preferred by more than 6 to 1 over any other option (see Figure 5-2), and currently available data suggest that consensus is forming around this option.

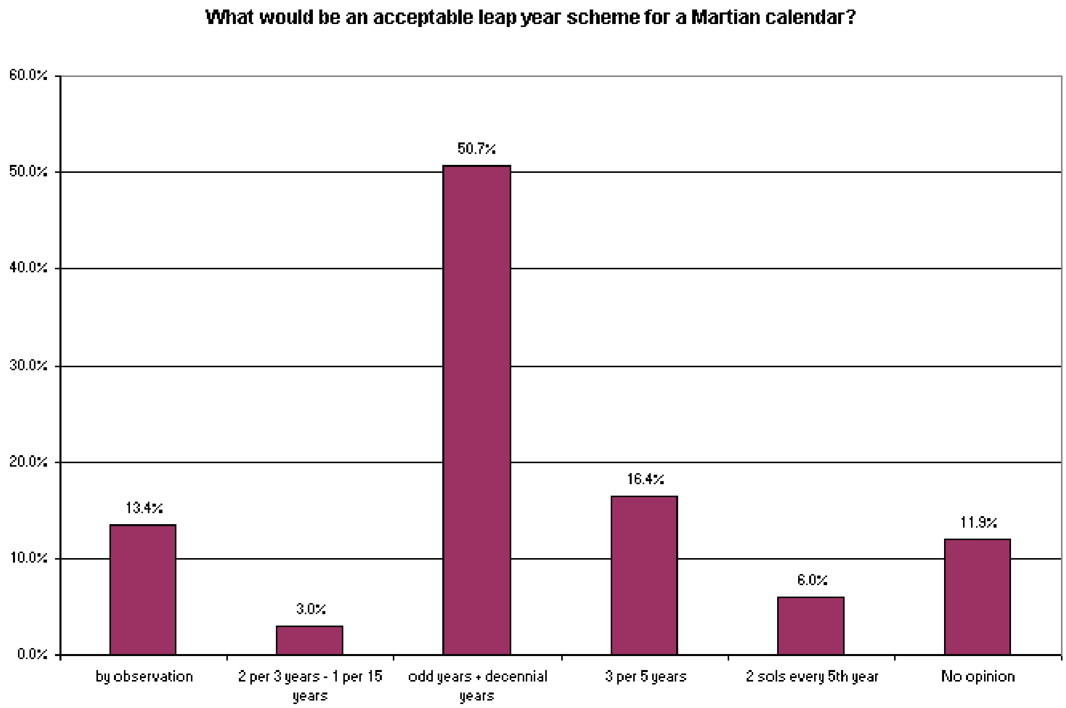

Figure 5-2 v1.

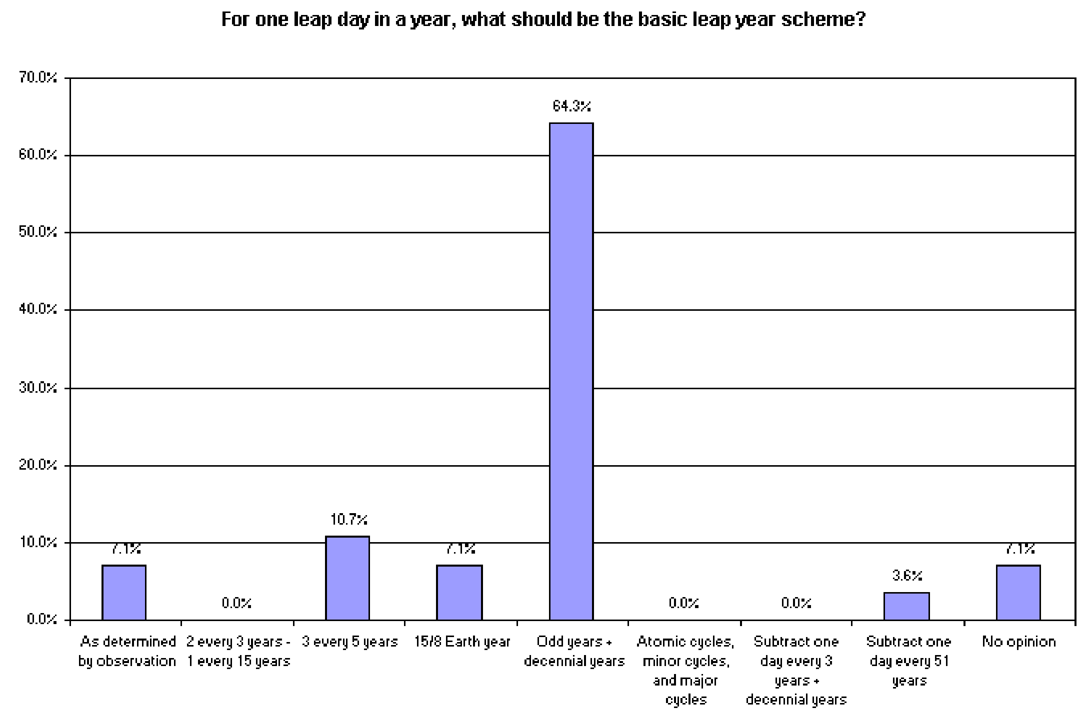

Figure 5-2 v2.

Figure 5-2a shows the history of responses to v2.x Question 5-2 and its v1.0 antecedent.

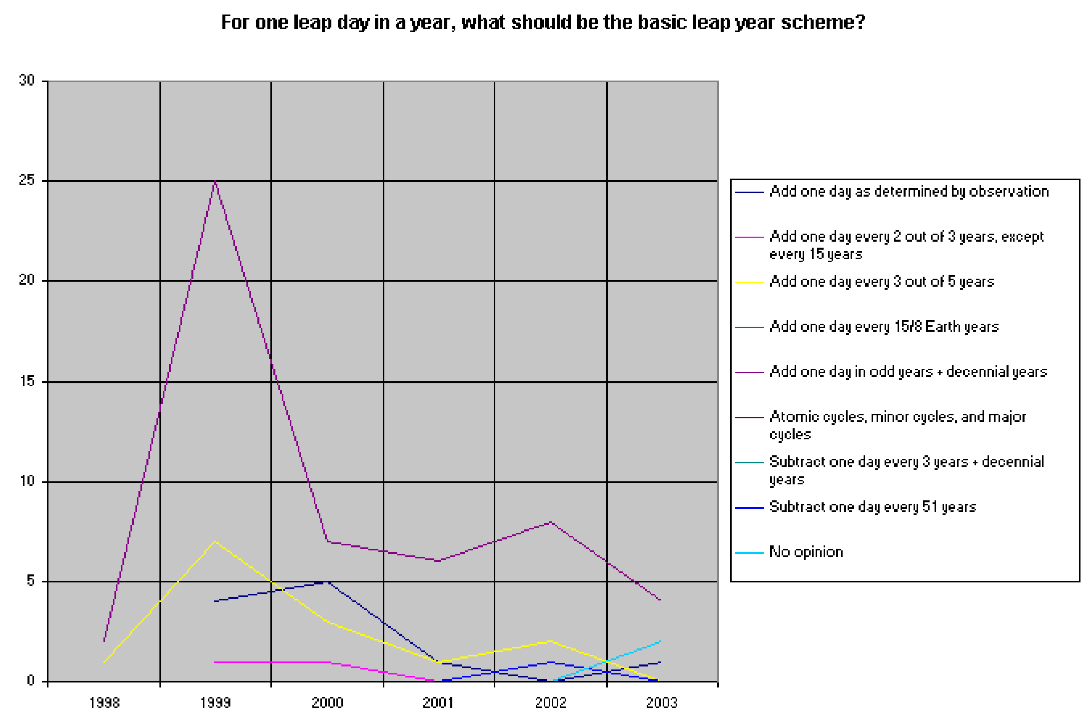

Figure 5-2a.

Version 1 Question 2-4 "When should the leap sols occur?" and Version 2 Question 5-3 "When should the leap days occur?" are nearly identically worded. Despite the fact that more than twice as many options were provided in Version 2.x, the "End of the year" option's share of total responses rose from 58.2% in Version 1.0 to 71.4% in Version 2.x. Placing the leap day at the end of the year was preferred in Version 2.x by 7 to 1 over any other option (see Figure 5-3). Based on the currently available data, it appears that the consensus for the "End of the year" option has grown significantly stronger.

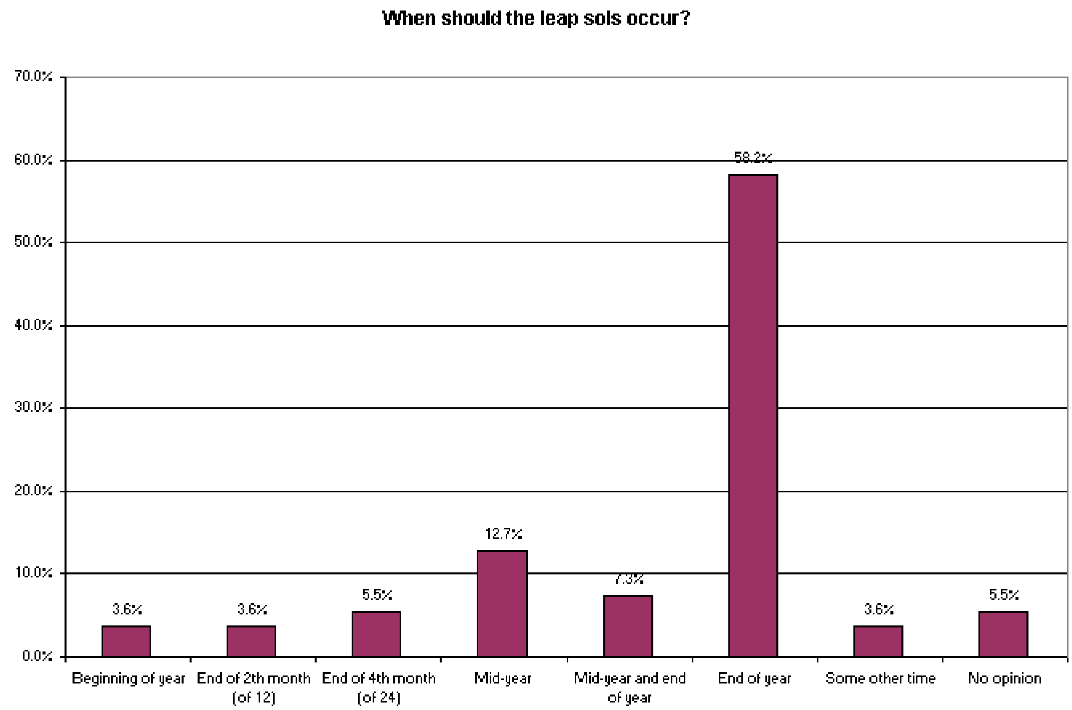

Figure 5-3 v1.

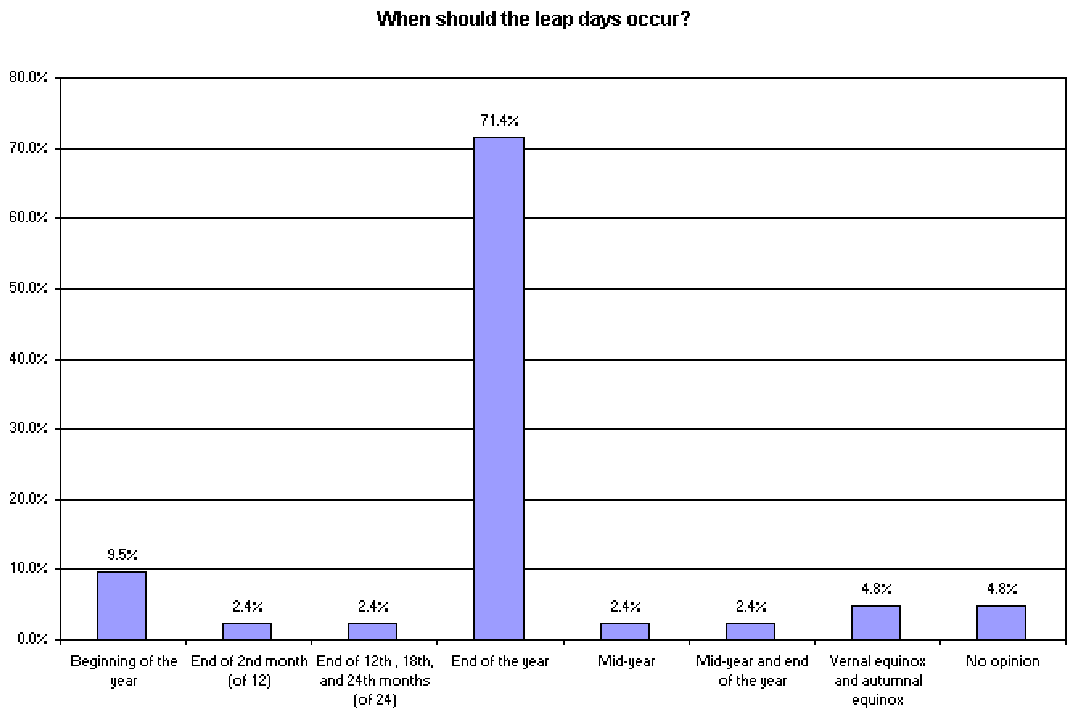

Figure 5-3 v2.

Figure 5-3a shows the history of responses to v2.x Question 5-3 and its v1.0 antecedent.

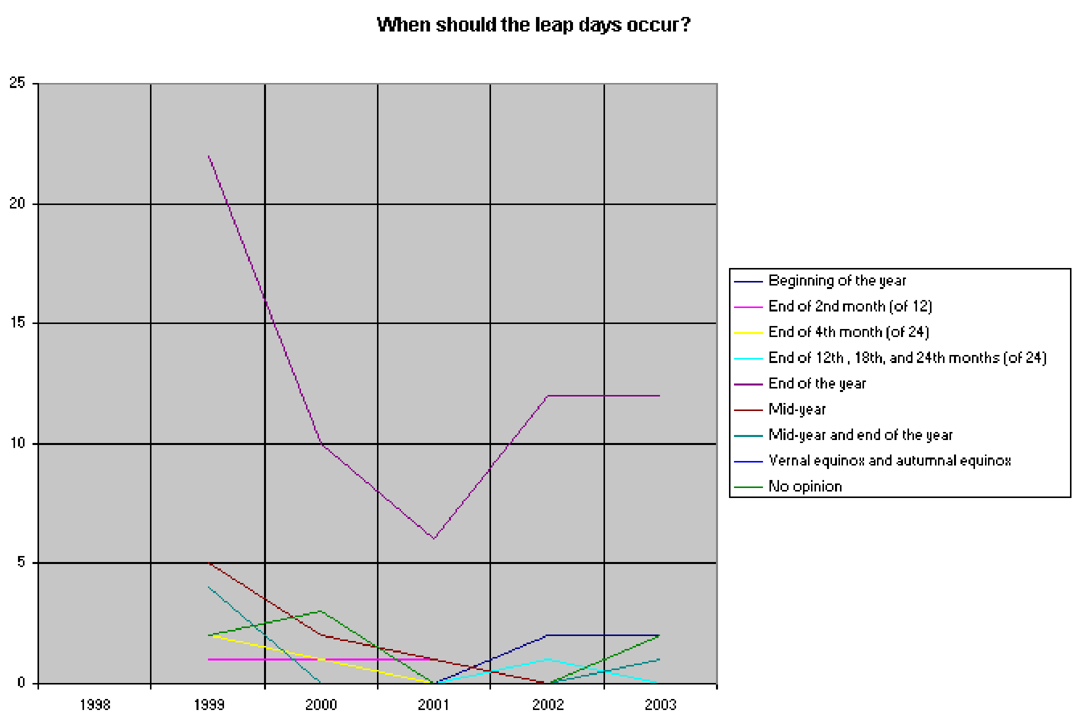

Figure 5-3a.

In Version 1.0, Question 1-2 asked, "Should Martian months always begin on the same sol of the week?" Although related, Question 5-2 of Version 2.x asked a somewhat different question: "What period of time should contain an integral number of weeks in order to effect a perpetual calendar?" The responses to the two versions of the survey are quite different at well. In Version 1.0, the "Yes" option received only 33.0% of responses, yet in Version 2.x, the "1 month" option accounted for 47.7%. Furthermore, the "1 month," "1 year," and "2 year" options (three modes for effecting a perpetual calendar) accounted for 65.9% of the responses, fully double the response rate for the "Yes" option in Version 1.0. It is possible that the way the Version 1.0 question was asked, respondents did not understand that having the months begin on the same day of the week would be necessary if there were to be an integral number of weeks in a month, or that doing so would result in a perpetual calendar. It is also possible that the way the Version 2.x question was worded, respondents did not understand that having the months contain an integral number of days would result in each month beginning on the same day of the week; however, the purpose for such an arrangement is contained in the question: the intention of effecting a perpetual calendar. Since most of the world now uses the Gregorian calendar for civil purposes, in which each month begins on a different day of the week, not only from one month to the next but from one year to the next, it is possible that many respondents are unfamiliar with the concept of a perpetual calendar when they first visit the website. The advantage of the Version 2.x website is that respondents have access to background information and can familiarize themselves with new concepts. Since the Version 2.x question specifically mentions the perpetual calendar concept, and the website provides access to explanatory information, it is reasonable to conclude that the responses to the Version 2.x question represent better informed choices. The responses to Question 2-5 of Version 1.0, discussed next, supports this conclusion.

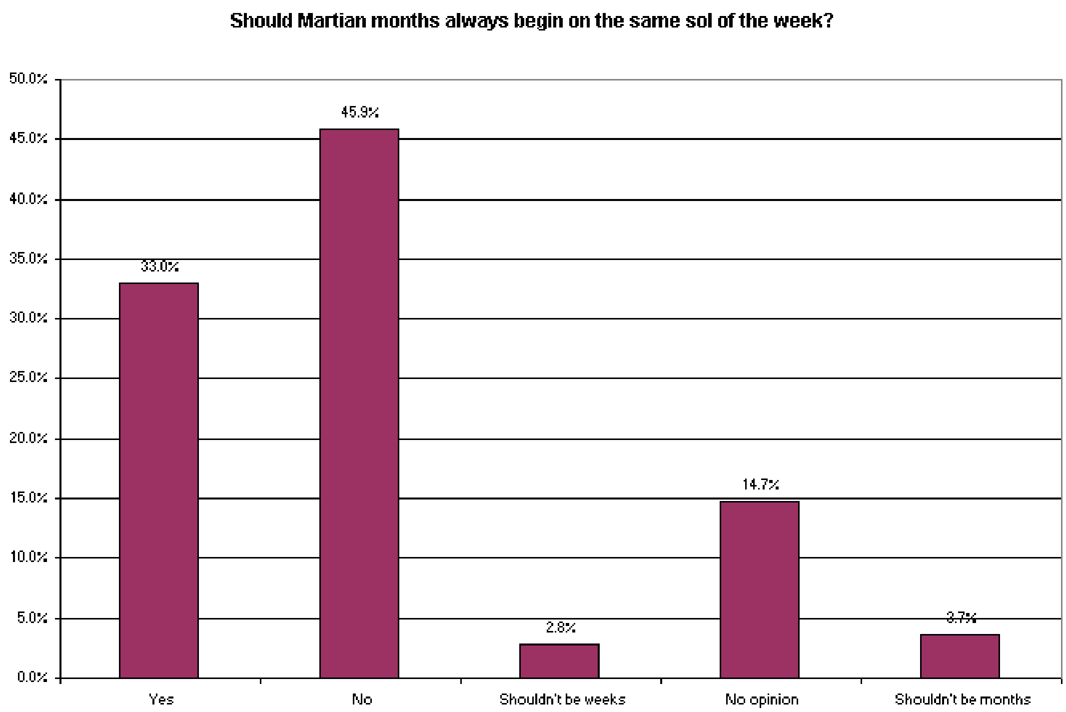

Figure 5-4a v1.

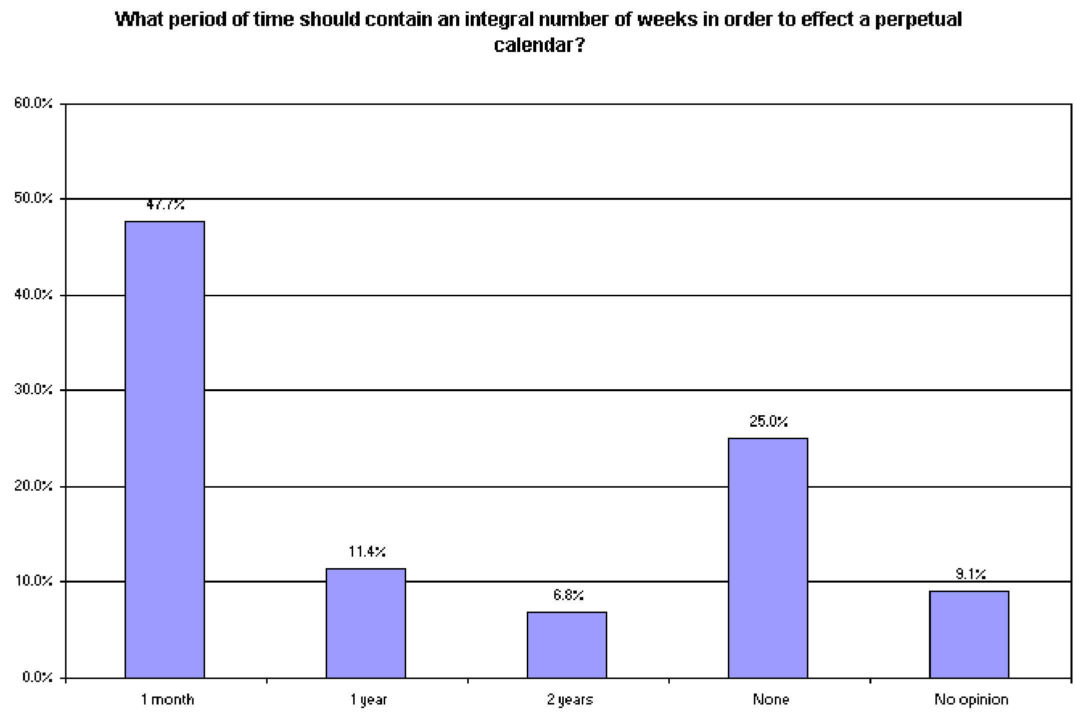

Figure 5-4a v2.

In Version 1.0, Question 2-5 "Should the calendar be perpetual (each year occurring on the same sol of the week)?" Again, although related, Question 5-2 of Version 2.x asked a somewhat different question: "What period of time should contain an integral number of weeks in order to effect a perpetual calendar?" The "Yes" option received moderate support at 50.9%, while 34.5% of respondents answered "No." This result stands in stark contrast to the response to the Version 2.x question, in which 65.9% of respondents selected one of the three options for effecting a perpetual calendar. This was a more than 2 to 1 margin over those 25.0% who chose "None" in regard to a repeatable cycle for the calendar.

The fact that a slight majority of respondents favored a perpetual calendar in Version 1.0, while at the same time rejecting by a 2 to 1 margin the idea of all months beginning on the same day of the week (see the discussion of Figure 5-4a), gives some support to the interpretation that a number of respondents did not make the connection between the two concepts. It should be pointed out that for a calendar to be perpetual, it is not necessary that every single month begin on the same day of the week, only that there be a repeatable pattern such that each non-leap year begins on one day of the week and each leap year begins on one day of the week (but not necessarily on the same day as non-leap years).

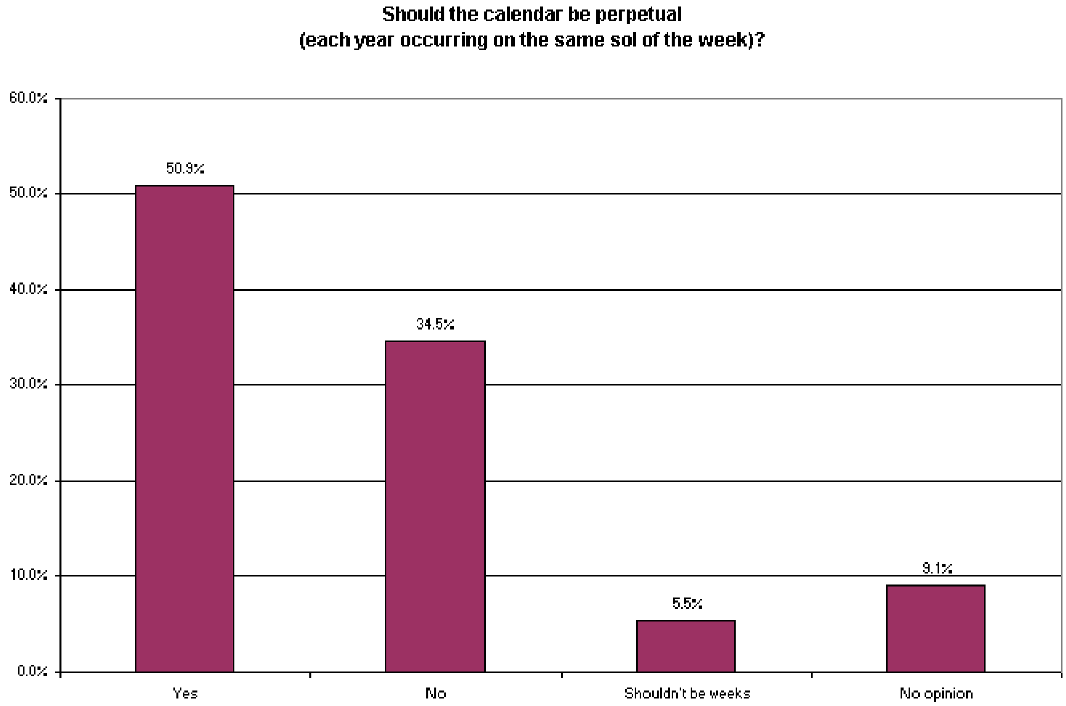

Figure 5-4b v1.

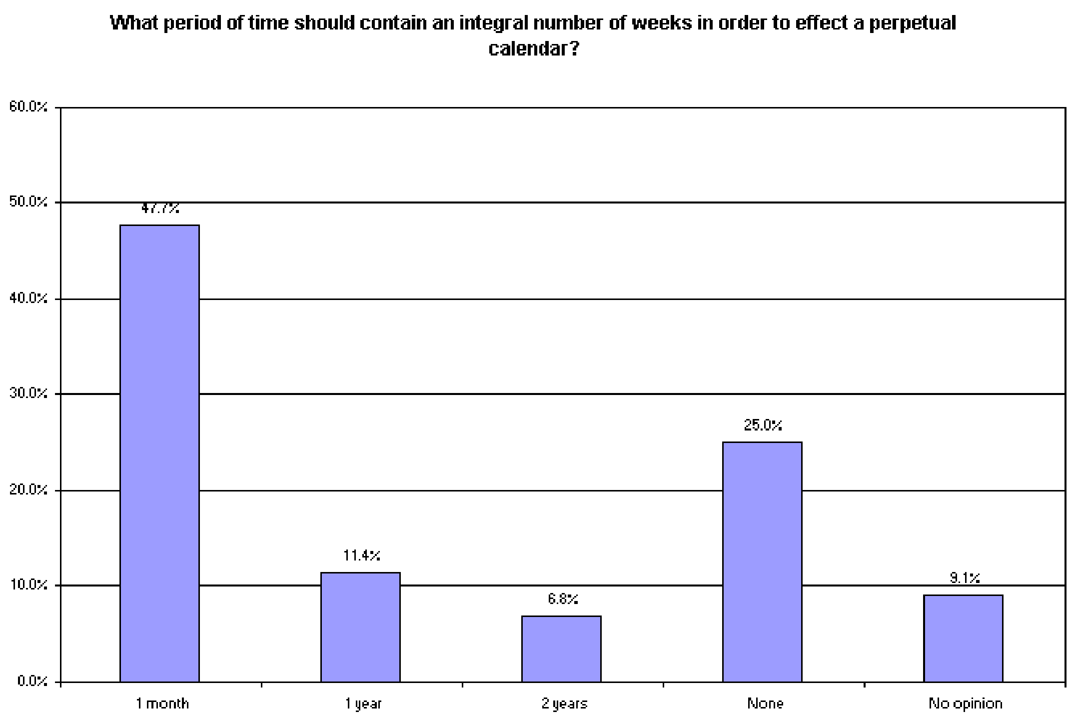

Figure 5-4b v2.

Figure 5-4c shows the history of responses to v2.x Question 5-4.

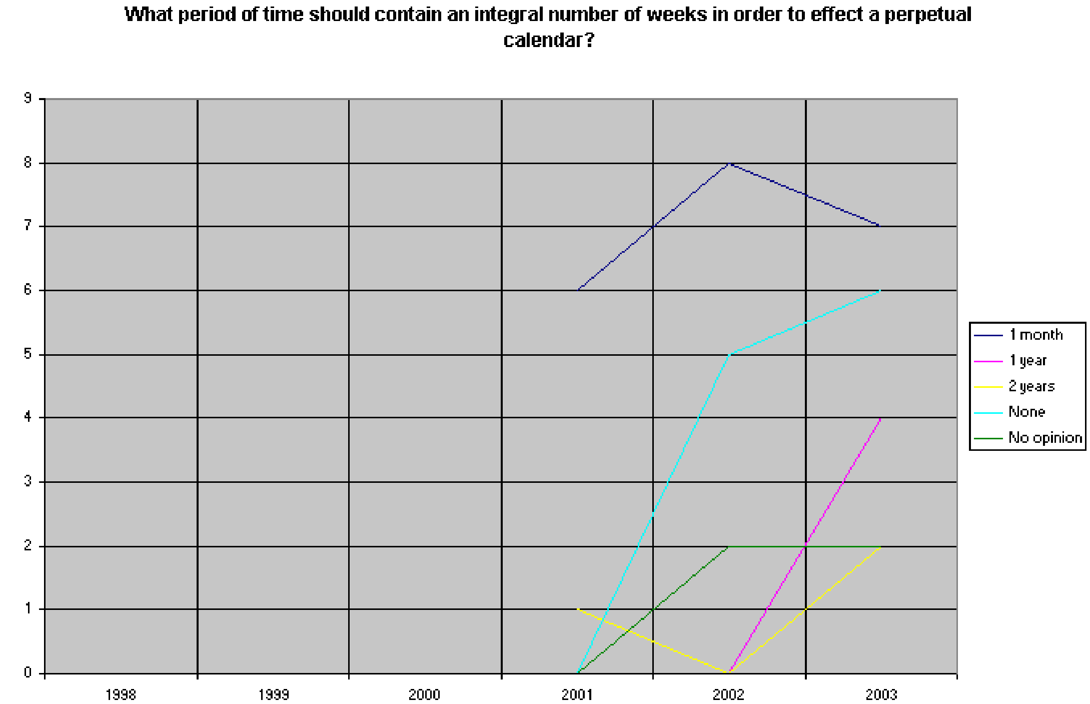

Figure 5-4c.

The December 2001 upgrade to Version 2.1 included a new Question 5-5: "For the purpose of devising a perpetual calendar, which of the following deviations is most desirable?" Responses to four of the seven possible non-"No opinion" were nearly even. Meanwhile, the "No opinion" response out-polled all others. Indeed, at 31.6%, the "No opinion" response to this question was the highest of any question in the survey. Clearly, there is no consensus on this issue.

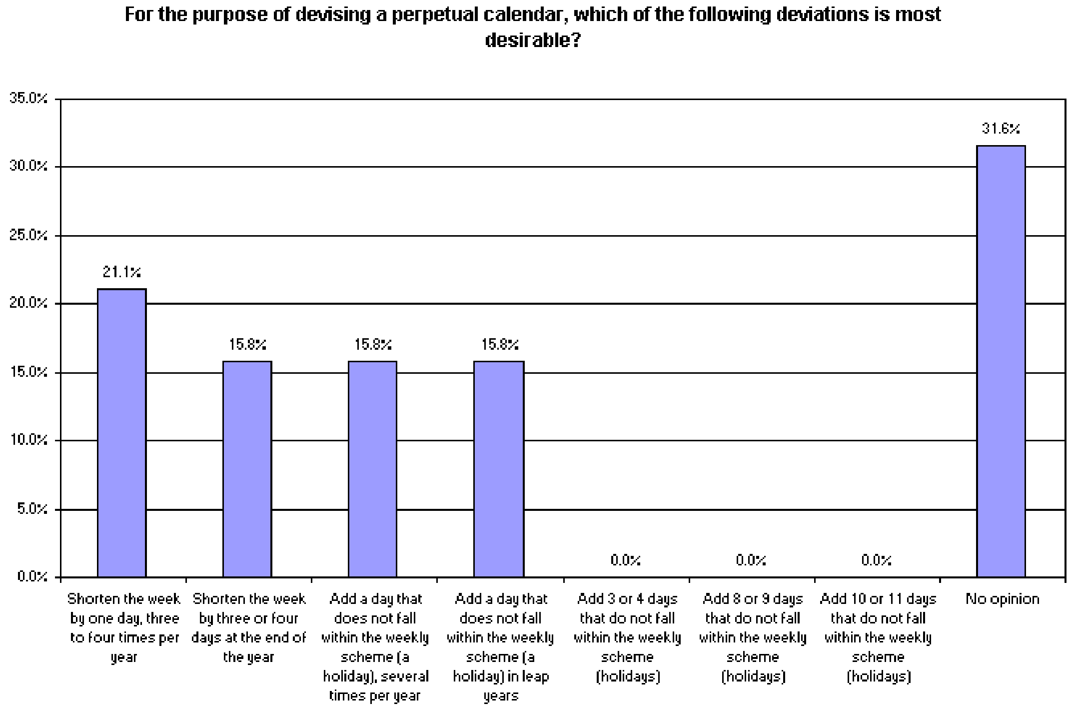

Figure 5-5.

Figure 5-5a shows the history of responses to v2.x Question 5-5.

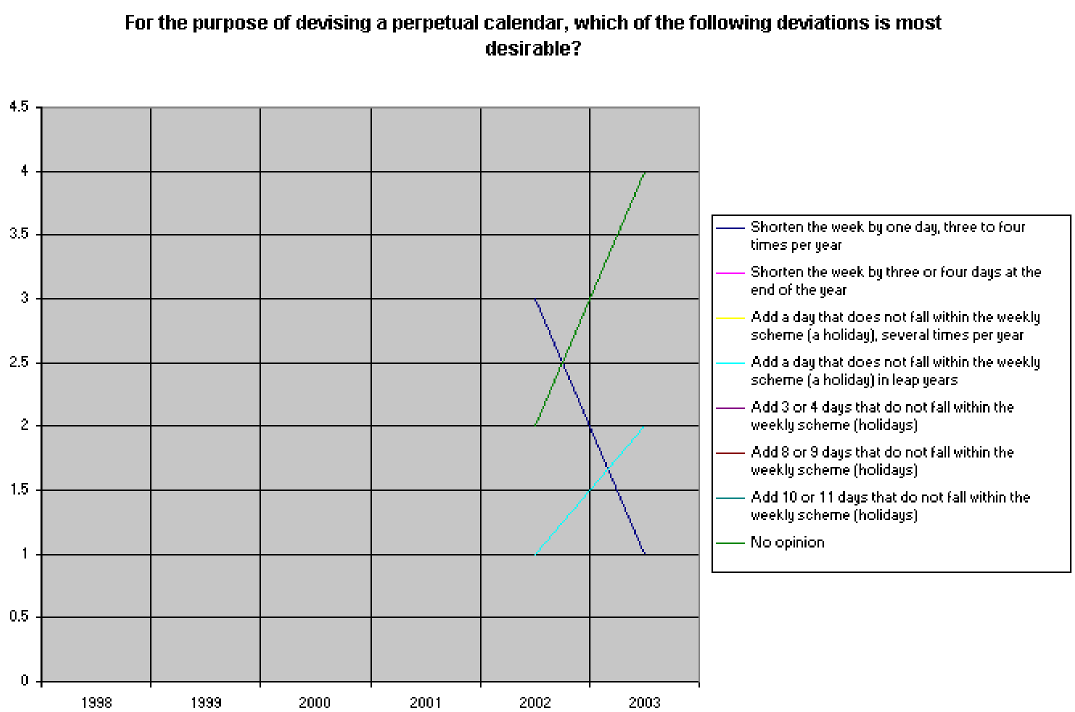

Figure 5-5a.

VI. The Epoch

In Version 2.x, Question 6-1 was also a new one: "When should people begin using a Martian calendar?" Respondents believing either that we should begin now accounted for 53.1%, while those who favored waiting for a future event were only 40.5% of respondents.

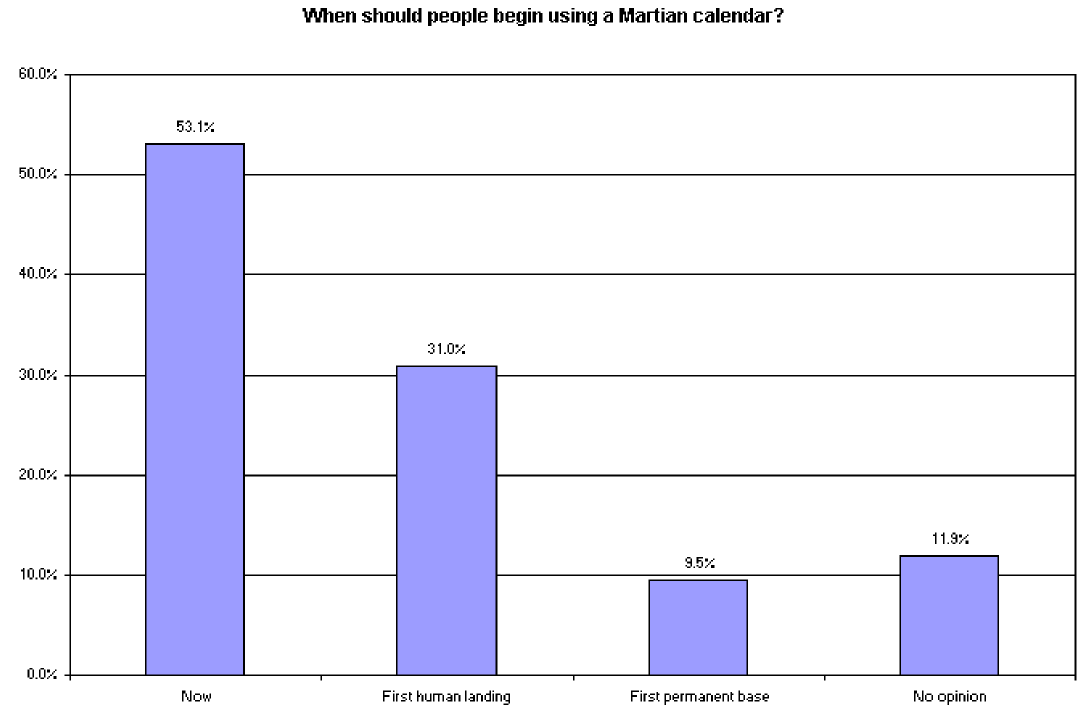

Figure 6-1.

Figure 6-1a shows the history of responses to v2.x Question 6-1.

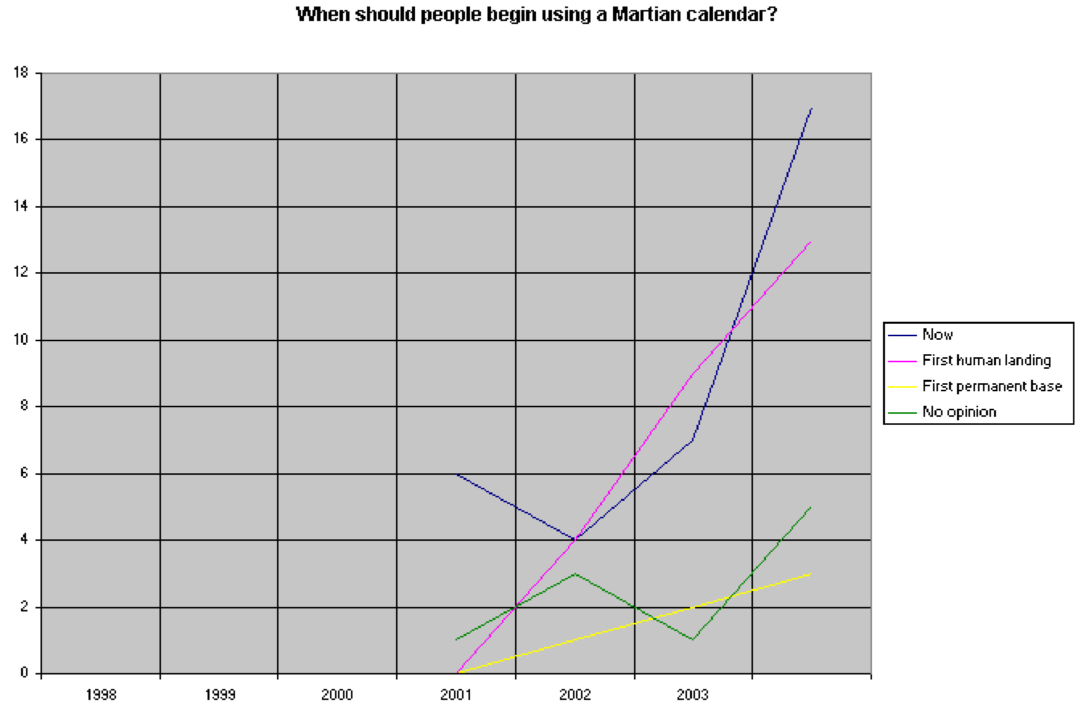

Figure 6-1a.

The December 2001 upgrade to Version 2.1 included a new Question 6-2 "On what annual cycle should the Martian numerical year increment?" With a response on 84.4%, respondents chose the "Martian cycle" option, which was nearly a 14 to 1 ratio over other options.

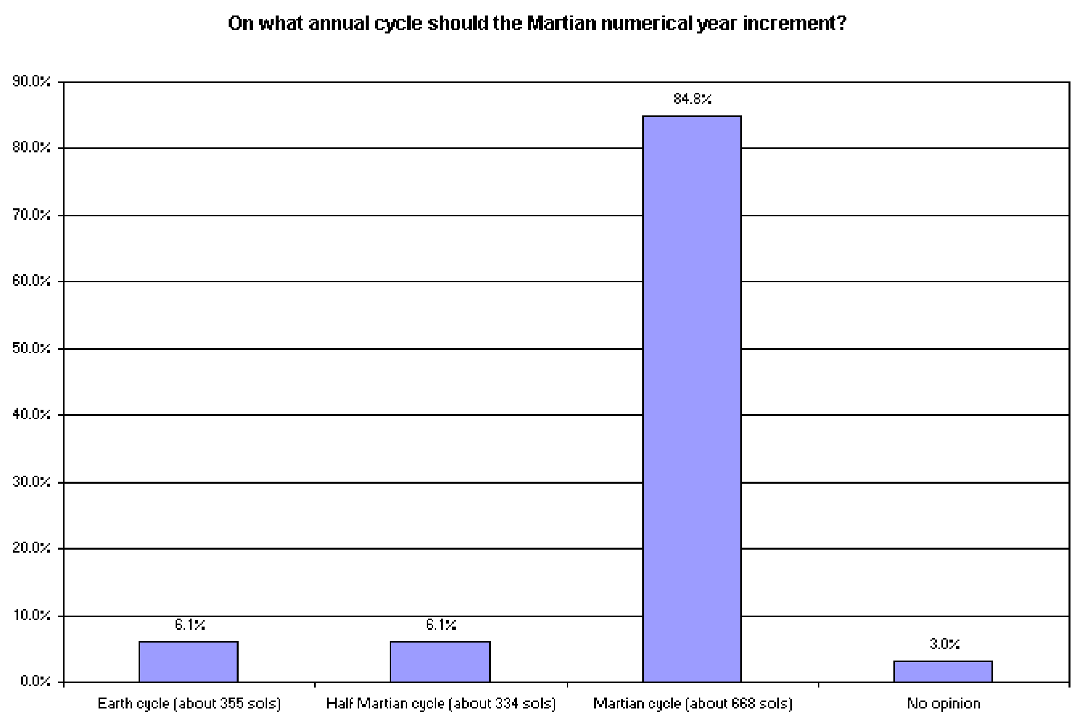

Figure 6-2.

Figure 6-2a shows the history of responses to v2.x Question 6-2.

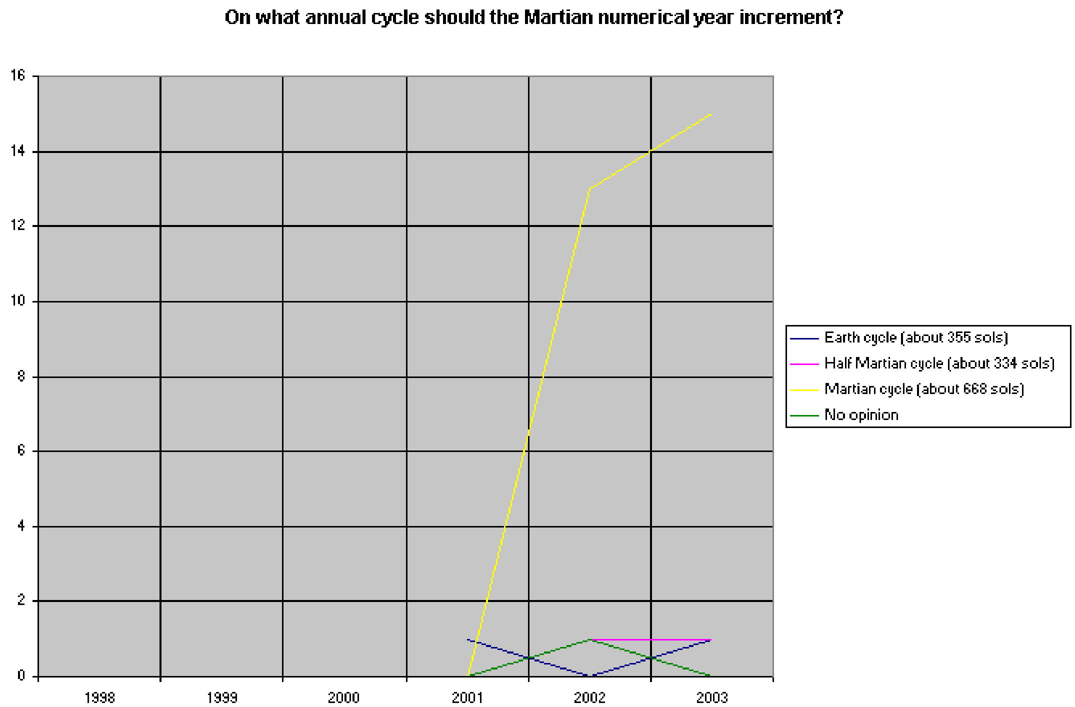

Figure 6-2a.

Question 1-9 in Version 1.0 "What event should mark the first Martian calendar year?" and Question 6-3 in Version 2.x "What event should begin the counting of calendar years?" are essentially the same; however, the two sets of responses are entirely dissimilar. In Version 1.0, the most popular option was "1st landing," and although it out-polled other options by 2 to 1, the response to this option accounted for only 28.4%, or barely a quarter of the total. In Version 2.x, support for this option dropped to 19.5%. Meanwhile, a new option not included in Version 1.0, "1609 CE," which represents the Martian year in which Kepler published his description of elliptical planetary orbits and Galileo initiated the era of telescopic astronomy, came literally out of nowhere to challenge the other leading historical options. However, none of the historical options polled as high as the "No opinion" option. Indeed, this question scored the second highest "No opinion" response in the entire survey. Overall, there is currently a lack of consensus on this question.

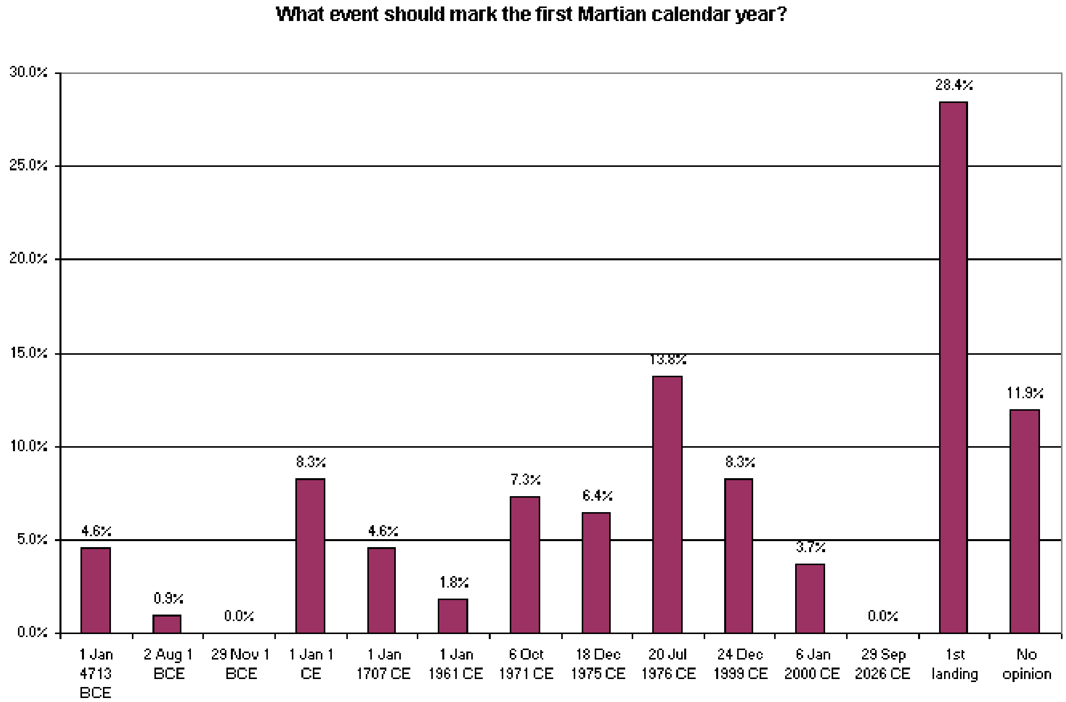

Figure 6-3 v1.

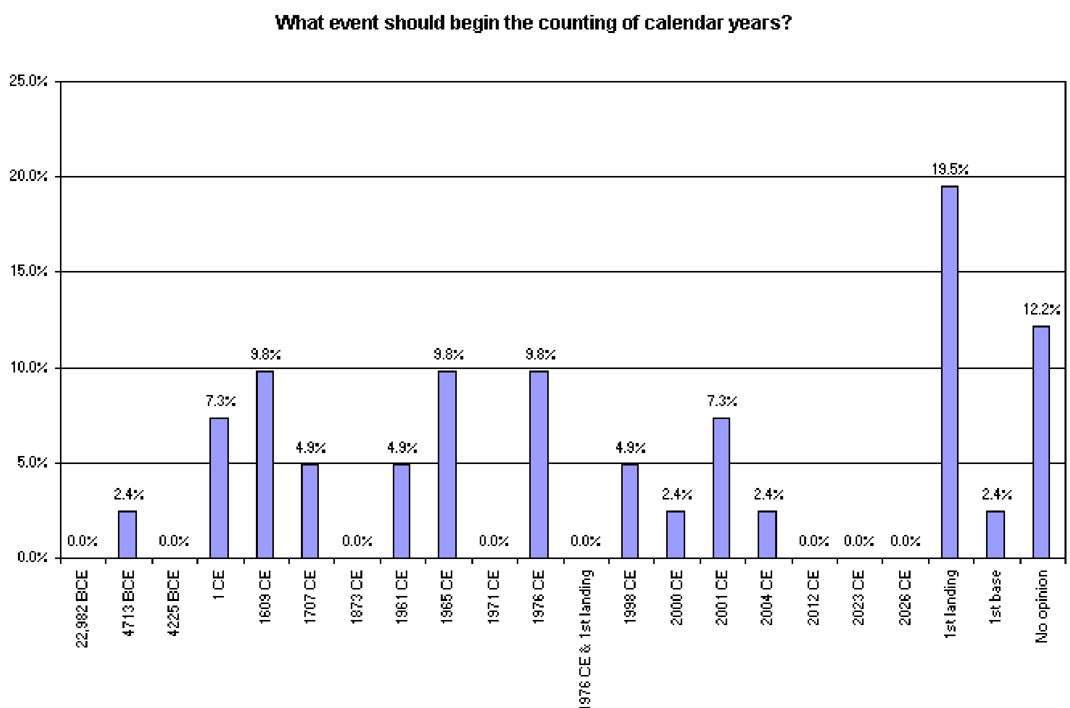

Figure 6-3 v2.

Figure 6-3a shows the history of responses to v2.x Question 6-3 and its v1.0 antecedent.

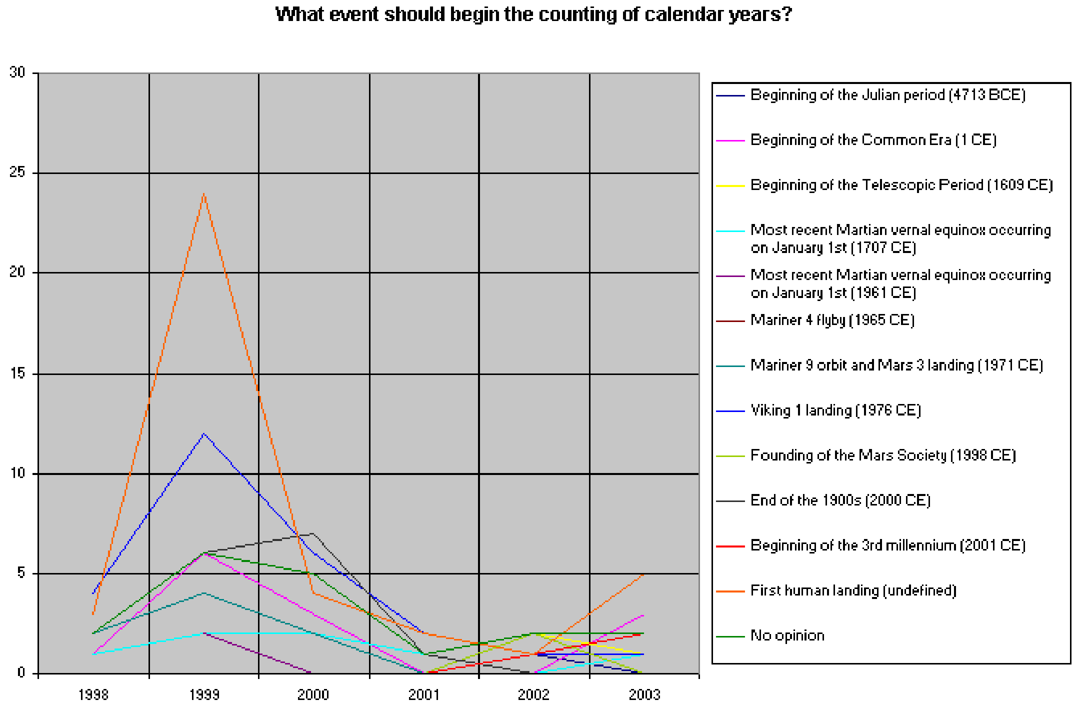

Figure 6-3a.

Version 1.0 Question 1-8 "On what sol should the Martian calendar year begin?" and Version 2.x Question 6-4 "At what time of the year should the calendar begin?" ask substantially the same question. The "0°" option, representing the vernal equinox of the northern hemisphere, polled 46.8% in Version 1.0, a 5 to 1 advantage over other options. Support for this option remained about the same at 45.2% in Version 2.x, with its margin over other options remaining quite high at a ratio of nearly 4 to 1.

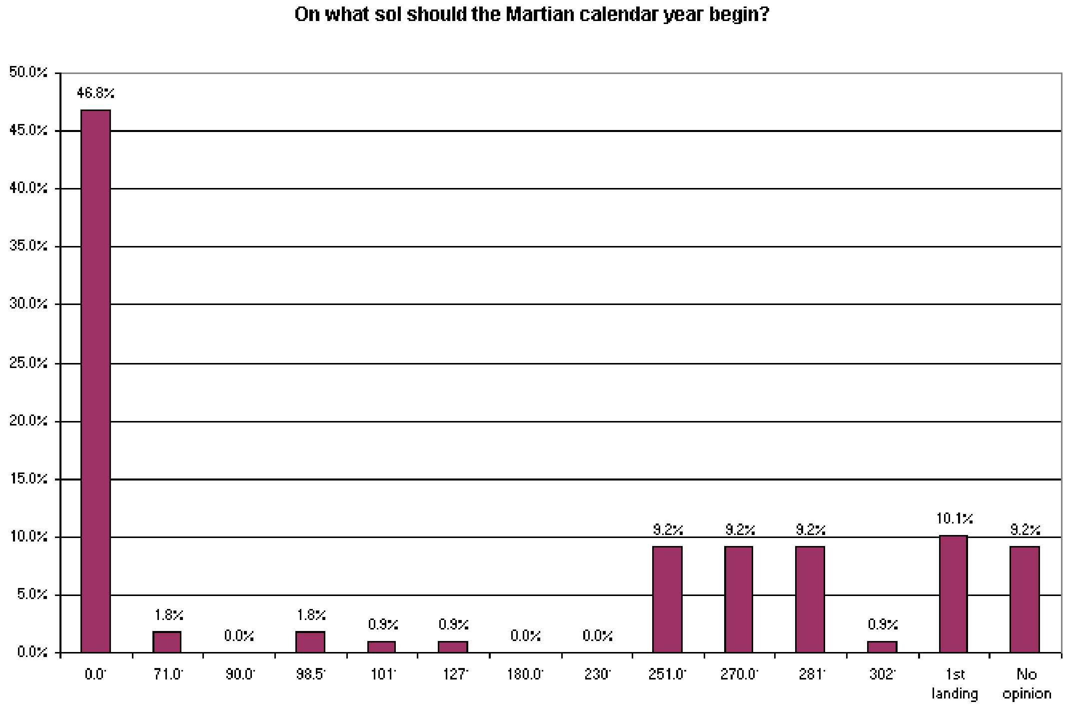

Figure 6-4 v1.

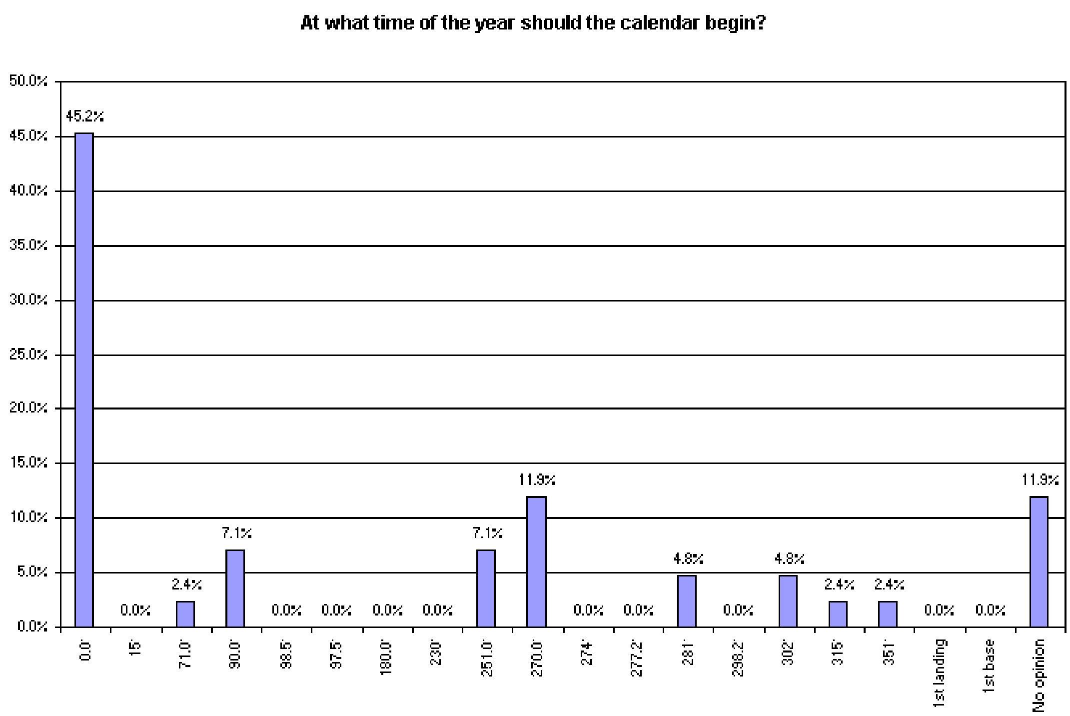

Figure 6-4 v2.

Figure 6-4a shows the history of responses to v2.x Question 6-4 and its v1.0 antecedent.

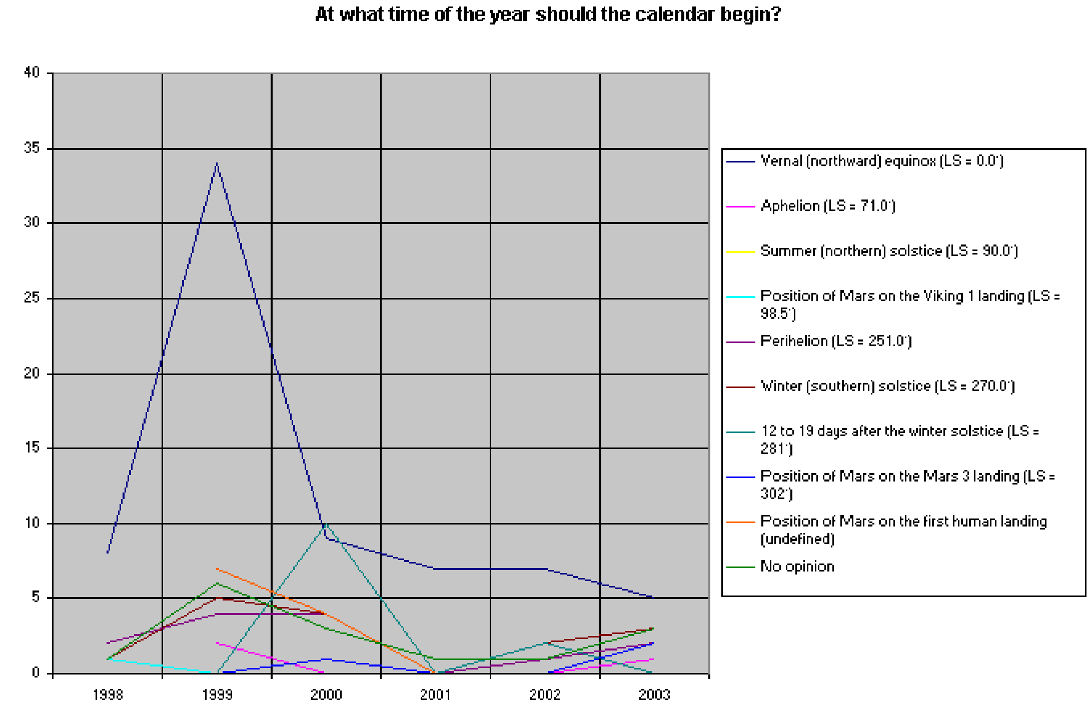

Figure 6-4a.

Question 1-10 in Version 1.0 "Should the first Martian calendar year be numbered 0 or 1?" and Question 6-5 in Version 2.x "Should the first calendar year be numbered 0 or 1?" are essentially the same; however, the two sets of responses are quite dissimilar. In Version 1.0, support for the "Year 0" and "Year 1" options were nearly evenly split, while in Version 2.x the "Year 0" option enjoyed a substantial advantage over the "Year 1" option. A possible explanation for this dramatic shift is that in Version 2.x, respondents had access to arguments for and against various options, and respondents themselves were empowered to write such arguments. In the case of the "Year 0" option, however, no one had offered an argument against it. Also, no one had written in favor of the "Year 1" option. Thus it may be that in Version 1.0 many respondents assumed a "Year 1" starting point without really considering the "Year 0" option and its implications, yet no one has come up with a good reason to select the "Year 1" option over the "Year 0" option.

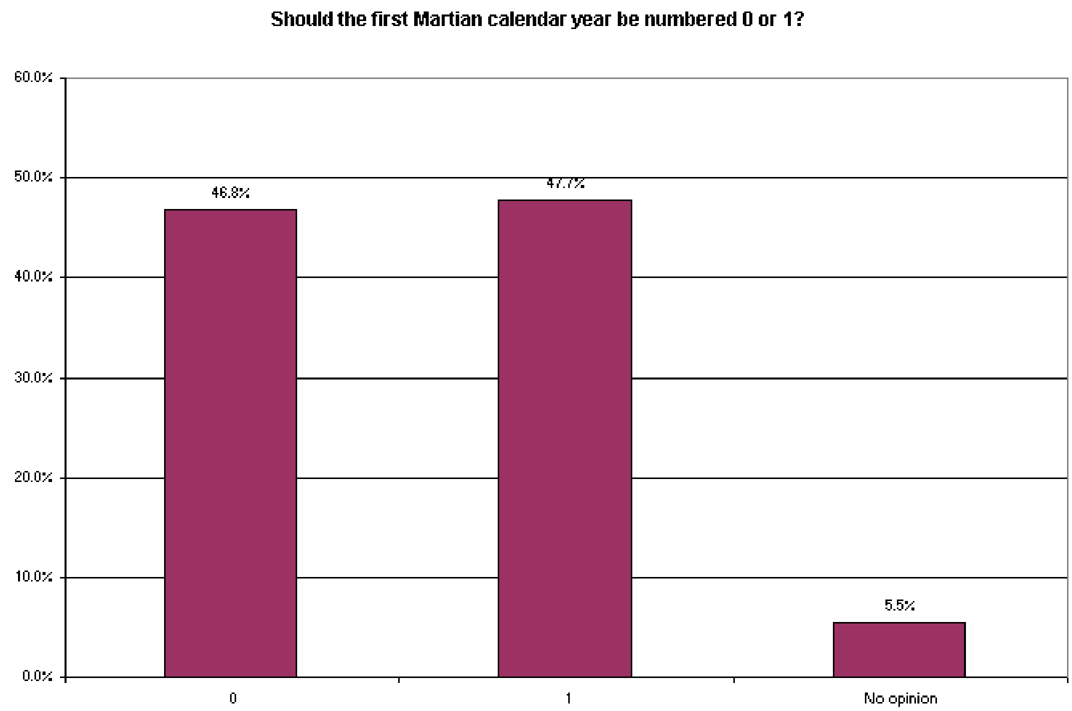

Figure 6-5 v1.

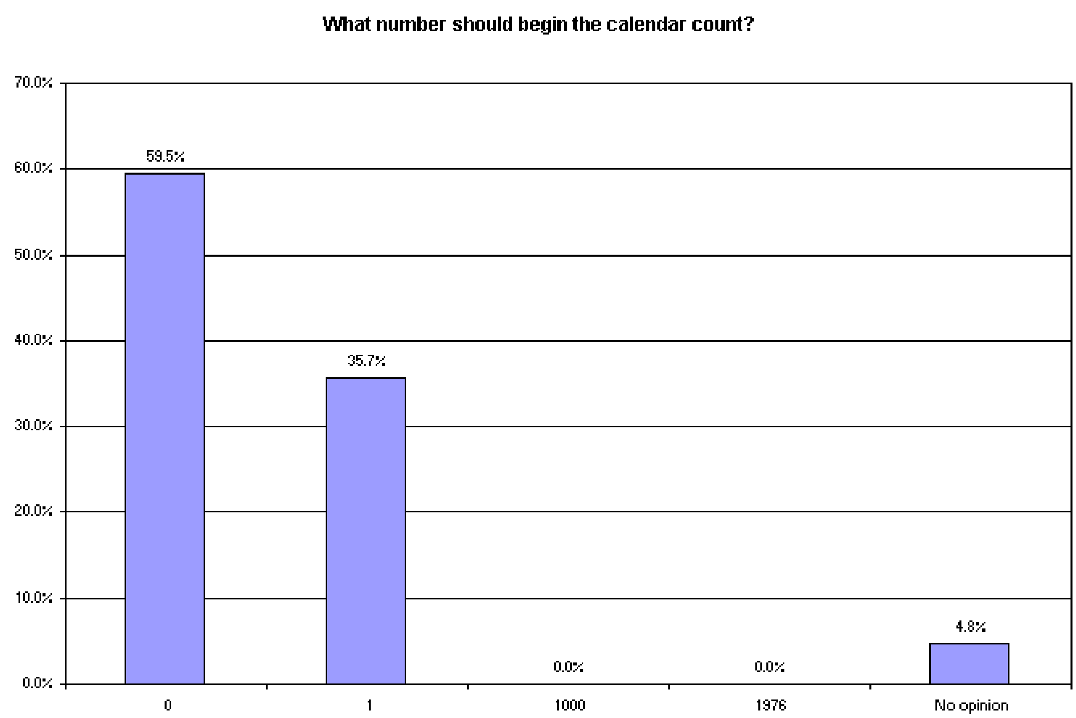

Figure 6-5 v2.

Figure 6-5a shows the history of responses to v2.x Question 6-5 and its v1.0 antecedent.

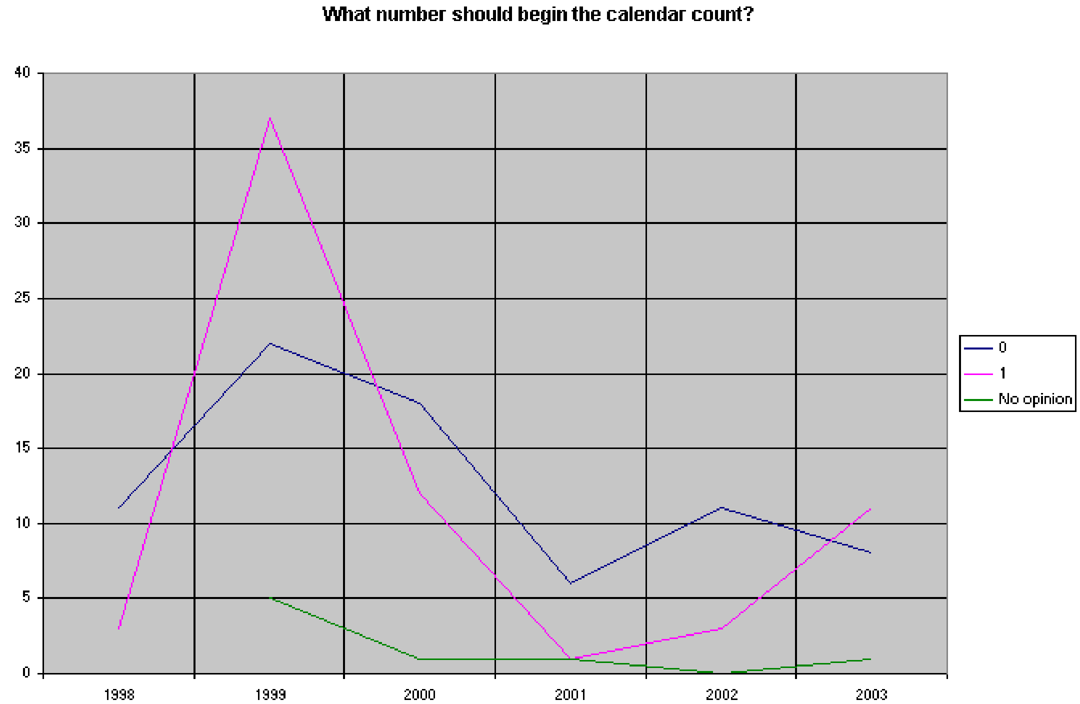

Figure 6-5a.

VII. Conclusion

In most cases, the data collected in Versions 2.0-2.2 is consistent with the results from Version 1.0. There is a strong consensus on the following aspects of Martian time:

- A 24-hour clock (8 to 1).
- 60 minutes per hour and 60 seconds per minute, these units being 2.75 percent longer than their terrestrial counterparts (2 to 1).
- A 7-day week (6 to 1).
- 24 equal-duration months, nominally 28 days each (4 to 1).
- A 668-day non-leap year and a 669-day leap year (7 to 1).
- A leap-year pattern of odd-numbered years plus decennial years (6 to 1).
- A leap day added at the end of the year (7 to 1).
- A perpetual calendar with an integral number of weeks per month (2 to 1).
- Begin using a Martian calendar now rather than wait for a future event (1.7 to 1).
- Increment the numerical year on the Martian cycle (14 to 1).
- Begin the calendar year on the northern hemispheric vernal equinox (4 to 1).

There remains some uncertainty on a few points. In Version 1, a slight majority favored a perpetual calendar, while a plurality opposed having all months beginning on the same day of the week. In Versions 2.0-2.2, however, respondents preferred a calendar that is repeatable on a monthly basis by a ratio of 2 to 1 over any other option. More data needs to be collected to confirm these later results. However, there is no consensus regarding the mode for effecting a perpetual calendar. Overall, the data (especially the high "No opinion" response of 31.6%) suggest that many people are unfamiliar with the concept of a calendar that is repeatable on a regular basis.

Support for establishing the date of the first human landing on Mars as the epoch for a Martian calendar eroded significantly from Version 1.0 to Version 2.X. This is consistent with the 2 to 1 preference for beginning the use of a Martian calendar immediately; however, no specific historical date has emerged as the clear favorite.

Finally, although the "Year 0" option emerged as the 1.6 to 1 favorite in Versions 2.0-2.2, in Version 1.0 respondents were evenly split between this option and beginning the year count with the "Year 1." In the background information file supplied with Version 2.x, the arguments in favor of "Year 0" and against "Year 1" are compelling, and there are no arguments in favor of "Year 1" or against "Year 0." It remains to be seen whether respondents will write such arguments and rally support for the "Year 1" option, or whether consensus will continue to coalesce around the "Year 0" option.

A significant difference in the responses in Version 2.x versus Version 1.0 was increased decisiveness. The "No opinion" responses dropped substantially from 10.7% in Version 1.0 to 6.1% in Version 2.x. This may be attributable to the availability of background information in Version 2.x to aid the respondent in making a decision. On the other hand, it must also be noted that the "No opinion" response rate rose to 9.1% in 2003, in spite of the existence of the information pages. One possible explanation is that the 2003 respondents had only a passing interest in Martian timekeeping issues in comparison to the 2001 and 2002 respondents (especially the early 2001 respondents, who were mostly MTVC members), and therefore had not formed as strong opinions. Also significant is that the 2003 responses generally tended to undermine the consensus recorded in 2001 and 2002.